Progress Report

Genetic Stock Identification of Yukon River Chum and Chinook Salmon 1987 to 1990

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by

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ABSTRACT

The chum and chinook salmon of the Yukon River are a shared resource between the United States and Canada. Negotiations began in 1985 to arrive at an equitable treaty between the two countries regarding the allocations of commercial and subsistence fisheries. One issue that needed to be addressed was the proportion of the U.S. catch that is of Canada origin. Protein electrophoresis was used to analyze the composition of commercial and test fish taken in District 1 (the lower Yukon River management area) throughout the fishing seasons of 1987 - 1990. Populations of Yukon River chum and chinook salmon of Alaska and the Yukon Territory were sampled from the tributaries to provide baseline data describing the genetic characteristics of individual stocks. Allelic data indicated that the genetic relationships among stocks generally followed a geographic pattern. Significant genetic differentiation was observed between the summer-run and fall-run chum salmon stocks. The level of differentiation within fall-run chum salmon stocks of Canada and U.S. was less than that observed between summer and fall-run stocks. Thus, genetic stock identification (GSI) estimates of stock composition estimates were more precise for separating summer and fall stocks than for U.S. and Canada stocks. The origin of chum salmon in the District 1 commercial fishery over the first four years of the study ranged from 82.0 to 91.0% U.S. summer-run ($\bar{x}$ = 85.7 ± 5.8%), from 5.7 to 10.6% U.S. fall-run ($\bar{x}$ = 8.6 ± 5.8%), and from 3.4 to 8.2% Canada fall-run chum salmon ($\bar{x}$ = 5.7 ± 4.7%). Of the fall-run fish, the proportion of chum salmon that were of U.S. origin ranged from 54.3 to 68.5% ($\bar{x}$ = 60.6 ± 44.7%). In numbers of fish, this equates to a four-year average harvest of 374,057 ± 25,102 U.S. summer-run, 33,200 ± 24,748 U.S. fall-run, and 22,208 ± 20,198 Canada fall-run chum salmon. The genetic relationships among chinook salmon stocks included a clear genetic separation between those of the upper and lower Yukon River, which also corresponded geographically to the boundary between the U.S. and Canada. Because of the correspondence of geographic and genetic stock groupings, the estimates of the proportion of U.S. and Canada stocks in the fishery, using this method, were both accurate and precise. The origin of chinook salmon harvested in the District 1 commercial fishery from 1987 - 1990 averaged 46.8 ± 5.1% United States-origin, and ranged from 38.7 to 58.1%. In numbers of fish, this equates to an average District 1 harvest of 27,623 ± 3,012 U.S. origin and 31,419 ± 3,012 Canada-origin chinook salmon. Based on the first four years of data, genetic stock identification is a feasible method for determining the relative magnitude of contribution to the fishery of chum and chinook salmon of the Yukon River drainage by country of origin and by major stock groups. Additional sampling and development of more genetic characters will be necessary to obtain accurate estimates of contributions by individual stocks were desired.

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INTRODUCTION

The United States and Canada began negotiations in 1985 concerning the allocation of Yukon River chum and chinook salmon. The Yukon River originates in the coastal mountains of British Columbia and flows for 3,250 km through the Yukon Territory and Alaska to the Bering Sea. The two most important commercial and subsistence fisheries in the Yukon River drainage are on chum salmon (*Oncorhynchus keta*) and chinook salmon (*O. tshawytscha*) (McBride et al. 1983). Fisheries in the Alaska portion of the drainage include salmon of Alaska and Canada origin, and Alaska fisheries have traditionally accounted for approximately 90% of the in-river harvest of both species in the Yukon River system (1961 - 1989 average; JTC 1990). An unknown proportion of the return of both species originates in the Canadian portion of the Yukon Drainage. To arrive at an equitable treaty between the two countries, the proportion of the U.S. catch of Canadian origin must be determined.

Chum salmon populations are found throughout the Yukon River drainage, and enter the river as two relatively distinct runs named for the seasons in which they spawn (Gilbert 1922). Summer-run chum salmon stocks are characterized by rapid maturation in fresh water, average 6-7 pounds in weight, and have a larger population size than the fall-run stocks (Bergstrom et al. 1991). Fall-run chum salmon stocks are characterized by robust body shape and bright silvery appearance, average 7-8 pounds, and have a smaller total population size (Bergstrom et al. 1991). Fall chum salmon are in great demand due to their appearance, size, and high oil content (Wilcock 1987).

The summer run enters the river beginning in early June and continuing until approximately mid-July (Buklis 1981). Summer-run chum salmon populations spawn throughout the summer months in runoff streams of the lower Yukon River up to the vicinity of Fairbanks, Alaska, 1,600 km from the river mouth.

In the lower Yukon River, the fall chum salmon run overlaps with the summer run in mid July, and continues usually until early September (Buklis 1981). Fall-run chum salmon spawn in September and October in spring-fed areas of tributaries of the middle and upper Yukon River (Bergstrom et al. 1991). Some major Yukon River tributaries support both summer- and fall-spawning chum salmon stocks, e.g., the Tanana River has predominantly fall-run chum salmon, but the Salcha River population spawns in the summer. The Koyukuk River system has both summer- and fall-run stocks occupying slightly different times and places (e.g., South Fork; Ken Troyer, USFWS, unpublished data).

Chinook salmon populations are widely distributed in the Yukon River drainage, with over 100 stocks identified (Barton 1984). Major chinook salmon-producing tributaries can be grouped geographically as lower (Andreafsky River and rivers draining the Kaltag Mountains), middle (Tanana River), and upper (Pelly River and rivers draining Big Salmon Mountains) Yukon River (McBride and Marshall 1983). Chinook salmon enter the Yukon River continuously from late May or early June through mid-July (summarized in Bergstrom et al. 1991), and they migrate to spawning grounds as much as 3,000 km from the river mouth (Milligan et al. 1986).

Two methods of estimating the composition of mixed-stock collections have been used to discriminate among U.S. and Canada stocks of chum and chinook salmon in Yukon River. Scale pattern analysis has demonstrated usefulness in Yukon River chinook salmon, and has been used for more than 10 years. Success using scale pattern analysis for discriminating among Yukon River chum salmon has been limited; the classification accuracies of discriminant models to apportion catch were low, not greatly different than expected by chance (Wilcock 1987). Because of low classification accuracies, the chum salmon mixed-stock fishery in District 1 has not been sampled for scale pattern analyses. The short interval during which chum salmon are affected by the freshwater environment may be responsible for lack of the discernible patterns of growth history that make scale pattern analyses a viable management tool for species like chinook salmon, which spend a year or more in fresh water environments. Preliminary genetic studies have shown detectable genetic differences among Yukon River chinook stocks (Beacham et al. 1989), and among chum salmon stocks (Beacham et al. 1988).

The results of the GSI study by the Canadian Department of Fisheries and Oceans (DFO) were based on seven genetically controlled proteins and used only fall-run chum salmon stocks in its baseline. The level of genetic separation between chum salmon stocks spawning near the border between Alaska and the Canadian Yukon Territory (Chandalar, Sheenjek, Fishing Branch, and Canadian mainstem stocks) was very low and attempts to apportion the catch by country of origin was unacceptable to the U.S. delegation. However, better precision (narrower confidence intervals) around stock composition estimates, and data gathered over the entire fishing season would better fulfill the needs of fisheries managers and negotiators.

Genetic stock identification (GSI) is a method that has been used on the west coast of North America to provide direct estimates of stock contributions to mixed stock salmon fisheries (e.g., Grant et al. 1980, Okazaki 1981, Wishard 1981, Miller et al. 1983, Beacham et al. 1985, Shaklee et al. 1990a). The method relies on identifying differences in relative frequencies of occurrences of genetically-controlled proteins of fish stocks (the baseline) using a technique called protein electrophoresis. Samples are then taken from a mixed stock fishery (the mixture sample) and the genetic characteristics of each fish are determined using protein electrophoresis. By comparing the genetic structure in the baseline to the genetic structure of the mixture sample, estimates can be determined for the contribution of each stock to the mixture. The model used to estimate the stock composition is based on pioneering work done by Grant et al. (1980), Milner et al. (1981), Miller et al. (1983), Fournier et al. (1984), Pella (1986), and Pella and Milner (1987).

In 1987, U.S. Fish and Wildlife Service (USFWS) research and management biologists in cooperation with the Alaska Department of Fish and Game (ADF&G) and DFO began to collect samples of Yukon River chum and chinook salmon from spawning stocks in tributaries, and from the mixed-stock fishery in District 1 near the Yukon River mouth. The goal of this preliminary study was to determine how accurately the GSI methodology could allocate the catch of chum and chinook salmon in District 1 by stock, by run timing, by major stock groups, and by country of origin. To build on the preliminary work of DFO, our objective was to add larger sample sizes to baseline and mixed-stock collections, add more genetic characters to the analyses, and to sample summer as well as fall chum salmon stocks. Chinook salmon were included in the study, as genetic studies showed detectable differences among U.S. and Canada stocks, and scale pattern analysis results could be compared with the results of genetic studies.

METHODS

To establish baseline genetic data for mixed-stock analysis, populations of chum and chinook salmon were sampled from Yukon River tributaries by USFWS, ADF&G, and DFO (Tables 1 and 2; Figure 1). Collections were made at more than one site and/or more than one year to assess the stability of allele frequencies. Sample sites were chosen based on 1) the magnitude of the runs, so that major contributors to the total run would be sampled preferentially, and 2) opportunities to reach remote locations. Collections were made on the spawning grounds preferentially, and from mainstem sites of major Yukon River tributaries (e.g., at sonar or weir sites) when logistically necessary. Adults were sampled whenever possible, but juvenile chinook salmon were collected from some drainages where adults were not sufficiently concentrated, or if spawners were not present.

In baseline (tributary) collections, target sample sizes for adult salmon were 75 individuals from a population, or at least 50 individuals if collections were from more than one site within a drainage. When juveniles were sampled, we attempted to collect at least 100 per tributary, spread over several locations within a drainage to reduce sampling of family groups.

Mixed-stock samples of adult chum and chinook salmon were collected, by personnel of USFWS and ADF&G, from fish processors near Emmonak, Alaska during commercial fishing periods, and from test net sites when the fishery was both open and closed (Appendices I, II, III and IV). When available between fishing periods, all test net salmon were sampled for genetic studies. From the commercial catch, the target sample size was 150 of each species

Table 1. Chum salmon baseline sample collection summary. Populations are listed in order of their geographical occurrences from the mouth of the Yukon River.

Population	N	River System	Sample Period		
			Year	Start	End
UNITED STATES					
Andreafsky	150	Andreafsky	1987	04-Jul	14-Jul
Chulinak (Atchuelinguk)	100	Chulinak (Atchuelinguk)	1989	10-Jul	11-Jul
Anvik	150	Anvik	1987	07-Jul	12-Jul
Anvik	100	Anvik	1988	15-Jul	15-Jul
Rodo	78	Rodo	1989	18-Jul	18-Jul
Nulato, Main	61	Nulato	1987	30-Jul	30-Jul
Nulato, South Fork	71	Nulato	1987	28-Jul	29-Jul
Nulato, North Fork	50	Nulato	1988	28-Jul	28-Jul
Gisasa	97	Koyukuk	1989	23-Jul	23-Jul
Koyukuk, South Fork, early	75	Koyukuk	1990	07-Aug	13-Aug
Koyukuk, South Fork, late	75	Koyukuk	1990	11-Sep	16-Sep
Henshaw	43	Koyukuk	1987	11-Aug	11-Aug
Jim	101	Koyukuk	1987	13-Aug	13-Aug
Tozitna	85	Tozitna	1989	26-Jul	26-Jul
Toklat	135	Tanana	1987	14-Oct	14-Oct
Toklat	75	Tanana	1990	30-Oct	30-Oct
Salcha	50	Tanana	1988	03-Aug	03-Aug
Salcha	50	Tanana	1989	30-Jul	30-Jul
Delta	135	Tanana	1987	28-Oct	28-Oct
Delta	75	Tanana	1990	31-Oct	31-Oct
Bluff Cabin	135	Tanana	1987	16-Oct	16-Oct
Chandalar	150	Chandalar	1987	03-Sep	05-Sep
Chandalar	73	Chandalar	1988	04-Sep	06-Sep
Chandalar	75	Chandalar	1989	27-Sep	28-Sep
Sheenjek	135	Porcupine	1987	21-Sep	21-Sep
Sheenjek	80	Porcupine	1988	21-Sep	21-Sep
Sheenjek	80	Porcupine	1989	13-Sep	13-Sep
CANADA					
Fishing Branch	129	Porcupine	1987	13-Sep	04-Oct
Fishing Branch	50	Porcupine	1989	07-Oct	08-Oct
Kluane	135	White	1987	04-Nov	04-Nov
Big Creek	70	Yukon	1987	28-Oct	28-Oct
Minto	100	Minto	1989	27-Oct	28-Oct
Tatchun	75	Tatchun	1987	01-Nov	01-Nov
Teslin	95	Teslin	1989	06-Sep	06-Sep

Table 2. Chinook salmon baseline sample collection summary. Populations are listed in order of their geographical occurrences from the mouth of the Yukon River.

			Sample Period		
Population	N	River System	Year	Start	End
UNITED STATES					
Andreafsky	100	Andreafsky	1988	02-Aug	10-Aug
Anvik	40	Anvik	1987	18-Aug	18-Aug
Anvik	60	Anvik	1988	04-Aug	15-Aug
Nulato, South Fork	50	Nulato	1988	26-Jul	28-Jul
Nulato, North Fork	50	Nulato	1988	26-Jul	26-Jul
Gisasa	47	Koyukuk	1987	08-Aug	08-Aug
Gisasa	91	Koyukuk	1988	02-Aug	04-Aug
Henshaw	87	Koyukuk	1987	12-Aug	12-Aug
Koyukuk, South Fork	112	Koyukuk	1987	25-Aug	25-Aug
Jim	79	Koyukuk	1987	13-Aug	25-Aug
Chena	151	Tanana	1987	05-Aug	07-Aug
Chena	98	Tanana	1988	29-Jul	29-Jul
Salcha	100	Tanana	1988	30-Jul	30-Jul
CANADA					
Klondike, North Fork	50	Klondike	1990	23-Aug	26-Aug
Klondike, North Fork	44	Klondike	1989	01-Sep	01-Sep
McQuesten	38	Stewart	1989	31-Aug	31-Aug
McQuesten	200	Stewart	1990	23-Aug	26-Aug
Ross	14	Pelly	1988	?	?
Ross	30	Pelly	1989	25-Aug	26-Aug
Blind	150	Pelly	1989	27-Aug	27-Aug
Tatchun	49	Tatchun	1988	30-Aug	30-Aug
Tatchun	29	Tatchun	1989	26-Aug	28-Aug
Big Salmon	49	Big Salmon	1988	26-Aug	28-Aug
Big Salmon	77	Big Salmon	1989	24-Aug	25-Aug
Little Salmon	35	Big Salmon	1988	22-Aug	22-Aug
Little Salmon	27	Big Salmon	1989	23-Aug	29-Aug
Bear Feed	87	Big Salmon	1989	28-Aug	28-Aug
Takhini	26	Teslin	1988	30-Aug	31-Aug
Takhini	26	Teslin	1990	28-Aug	30-Aug
Stony	121	Teslin	1990	30-Aug	30-Aug
Nisutlin	71	Teslin	1989	20-Aug	25-Aug

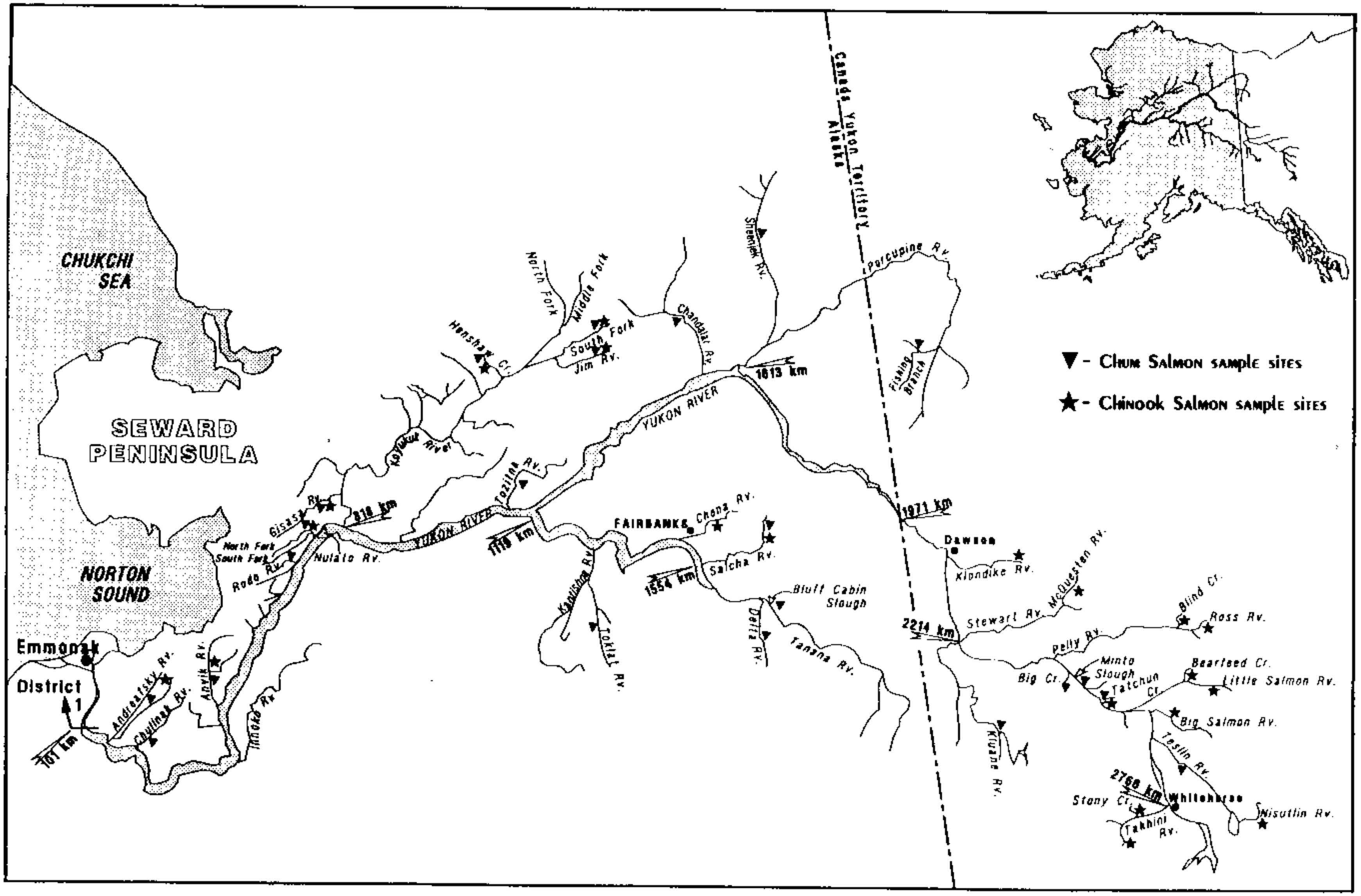

Figure 1. Map of the Yukon River system showing sample sites, species collected at those sites, Alaska Department of Fish and Game fishing District 1, and distances (in kilometers) from the river mouth to designated locations.

per fishing period, which were usually opened twice a week throughout the summer. The chum salmon fishery was closed for some periods in 1987, 1988, and 1990, and all genetic samples were from test nets during these periods.

Four tissues (muscle, liver, eye, and heart) were taken from each fish for protein electrophoresis; in the latter years of the study, cheek muscle was sampled instead of skeletal muscle for both chum and chinook salmon. Tissue samples were put in matching sets of individually labelled tubes, cross-referenced to an ADF&G sample number, frozen, and shipped to the USFWS laboratory in Anchorage, and stored at -70°C prior to analysis.

Protein electrophoresis followed standard techniques described by Aebersold et al. (1987) and Gall et al. (1989). Gene nomenclature follows recommendations of Shaklee et al. (1990b). A total of 48 proteins coded by 70 genetic loci were screened in chum salmon, and 50 proteins coded by 67 loci were screened in chinook salmon (Appendices V and VI).

Nineteen loci for chum salmon and 22 loci for chinook salmon were used for mixed-stock analyses (Appendices V and VI). The loci were selected based on four criteria: 1) they must have been analyzed and scored for all baseline and mixed-stock fishery collections; 2) the allelic variability must have been observed in at least one collection; 3) the observed banding patterns must have conformed to known models of inheritance among salmonid species; and 4) the patterns must have been repeatable among tissues.

For paired loci with protein products of indistinguishable mobility (isoloci; Allendorf and

Thorgaard 1984; e.g., *sAAT-1,2* in chum salmon), the observed genetic variation was assigned to a single locus of the pair. Only a low level of variation was observed at isoloci studied in Yukon River chum and chinook salmon (frequency of the alternate genotype less than 1% in any population). The observed genotype frequencies were not statistically different than expected using a single-locus model (using Pearson's chi-square to test goodness-of-fit).

Rare alleles (variants with an observed frequency less than 0.01), which offer little discriminatory power among stocks, were pooled with variants that were not rare prior to statistical analyses (Appendices VII and VIII).

In chinook salmon, the heterozygote at the *sMEP-2* locus could not be distinguished from the common homozygote. For the genetic stock identification analyses, this locus was treated as if it was a non-genetic trait with only two character states.

For each collection, the observed genotype distribution for each locus was tested against the proportions expected in a random mating, randomly sampled population (Hardy-Weinberg equilibrium) with a χ^2 goodness-of-fit test. To reduce the number of spurious significant tests caused by rare genotypes and sampling error (Type I error), two methods of pooling observed genotypes were used. The exact significance probabilities were calculated (analogous to Fisher's exact test) with a modification which pools genotypes into three classes when more than two alleles are observed. Loci not in expected Hardy-Weinberg proportions using this statistic were re-tested with the χ^2 test and genotypes were pooled if the expected number in any cell was less than four. The data sets for each of 34 stocks of chum salmon include up to 19 variable loci, and 31 collections of chinook salmon include up to 22 variable loci; 1 in 20 tests are expected to give "false positive" (Type I errors) in each population by chance alone, assuming that the loci studied are segregating independently.

Baseline data sets from multiple collections from different times or different sites within river systems were compared using heterogeneity log-likelihood ratio statistics both pairwise and simultaneously among groups (G-test: Sokal and Rohlf 1981). Collections from the same site made at different times were not pooled prior to analyses if significantly different ($P < 0.01$). The more liberal significance level ($P < 0.01$ versus the standard 0.05) reflects the "decision" of the West Coast salmon genetics working group that pooled collections from multiple years provide a better estimation of actual allele frequencies of given population with overlapping generations than does a single collection (Robin Waples, NMFS, personal communication).

In this study, data sets from populations sampled at different sites within river systems generally were not pooled prior to GSI analyses, although pooling statistically indistinguishable stocks ($P > 0.05$), when many stocks are included in the baseline data set for a given project, is recommended by the aforementioned working group. For the Yukon River salmon study, relatively few stocks make up the baseline data set, and simulations with and without pooling of baseline data sets from stocks of different tributaries indicated that stock allocations were more accurate and precise when individual stocks were used in the baseline data set rather than pooled data. Only the Jim River and Henshaw Creek (Koyukuk River system) chinook salmon data were pooled prior to mixed-stock analyses since we were missing data for the *mSOD-1* locus for the Henshaw Creek sample, and the data for the other loci examined were not significantly different ($P > 0.05$).

Geographic and temporal patterns of genetic relatedness between baseline populations were examined using a measure of genetic distance (Nei 1972) using only variable loci in the analyses. Cluster analysis of the genetic distance data was done using the unweighted pair-group method (UPGMA; Sneath and Sokal 1973), and the results are presented as dendrograms. The pattern of relationships among stocks indicated by the results of the cluster analysis was used in conjunction with geographical location to assign stocks to the genetic/management groups used for reporting results of the mixed-stock analyses. A computer program designed for analyzing genetic data (BIOSYS-1; Swofford and Selander 1989), was used for the analyses described previously.

Stock contribution estimates of the mixed-fishery collections from the commercial and test net catch of District 1, Yukon River were calculated using a conditional maximum likelihood computer program (GIRLSEM), originally developed for fisheries applications by Milner et al. (1981), and refined by the National Marine Fisheries Service (NMFS; Pella and Milner 1987, Masuda et al. 1991) to use both the Estimization Maximization (EM) algorithm (Dempster et al. 1977) applied to stock identification by Millar (1987), and an Iteratively Reweighted Least Squares (IRLS) algorithm (described in Pella 1986). The GIRLSEM program calculates the most likely combination of baseline stocks that would be required to form the observed mixed-stock data, based on the assumption that the frequencies in the baseline populations are known exactly; the infinitesimal jackknife procedure (Efron 1982), applied to mixed-stock analysis by Millar (1987), was used as a measure of the precision of the estimates.

Since samples can only provide estimates of the actual genotype frequencies in the source populations and in the mixed-stock fisheries, bootstrap resampling (Efron 1982) of both the baseline and mixed-fishery data was used to provide a mean and standard deviation of 100 estimates of stock contribution for each collection. The bootstrap procedure estimates sampling error by drawing, with replacement, new random samples of the specified sample size from the data set being analyzed.

The sample size used for stock composition estimates depends on the level of precision required and the amount of variability among the stocks studied. For this study, data were combined so that each mixture included at least 180 individuals. The time periods used for the mixed-stock analyses for each year were chosen, where possible, to coincide with ADF&G commercial openings or test net periods. However, in several instances, data from samples collected during different ADF&G periods were combined in order to obtain an adequate sample size for analysis.

Simulated mixed-stock data sets, assembled from known proportions of baseline data, were analyzed for stock composition in order to test the accuracy and precision of stock allocations of Yukon River chum and chinook salmon to management groups. Three series of artificial mixtures were performed to determine how well the program could discriminate 1) between summer-run and fall-run chum salmon stocks, 2) between U.S. fall-run and Canada fall-run chum salmon stocks, and 3) between U.S. and Canada chinook salmon stocks. A series of six artificial mixed-stock data sets were constructed for each pair of comparisons so that the proportion of each group being tested increased in frequency in the mixture incrementally by 20% from 0 to 100%. Equal proportions of all stocks belonging to each group, drawn from the baseline data set, were used to make up the mixtures.

A second set of simulations was done using all stocks from the baseline data set contributing to the appropriate group in proportions reflecting their relative abundance from ADF&G escapement counts for the years 1987-1990 (JTC 1990). These simulations were done using the program GIRLSYM (Pella, Masuda, and Nelson, NMFS, in preparation), which uses the maximum likelihood algorithms described above as well as "drawing" the data from the baselines to form the artificial mixed-stock data sets. Individual stock contribution estimates were summed across stock groups. The precision of the estimates is reported as one standard deviation of the mean stock proportions, derived from 100 iterations of bootstrap resampling. The data are presented as accuracy graphs, which illustrate the expected and observed allocations to baseline stocks.

A second simulation program (SIMOBS: Michele Masuda, NMFS, personal communication) was used to test for the ability of the maximum likelihood procedure to detect the addition of data from a stock or stock group, specified by the investigator, to actual mixed-fishery data. Data from the stock being investigated was generated from baseline data, and added incrementally to constitute from 0 to 45% of the mixed-stock data. Two mixed-stock collections were tested in this manner. First, the chum salmon collected during the time period from June 22 to June 29, 1990, estimated using mixed-stock analysis to include less than 1% fall-run fish, were tested with incremental additions of data from six different fall-run stocks or combinations of stocks (Tanana, Chandalar/Sheenjek, Fishing Branch, Mainstem Canada, Kluane/Teslin, and Canada fall run). Second, the August 3 to August 8, 1990 chum salmon collection, with no summer-run stocks detected using mixed-stock analysis, was tested for detection of additions of Koyukuk River data, then Anvik River data (both summer-run stocks). As in the previous procedures, estimates of the stock proportions of these combination artificial and actual mixture files were estimated using maximum likelihood statistics, with 100 iterations of bootstrap resampling to determine the magnitude of the error associated with the estimates.

RESULTS

Chum Salmon

Relationships among stocks

Of the 70 loci screened in Yukon River chum salmon, variation was observed at 39, and 19 met the criteria for genetic stock identification (Appendix VII). When tested for conformance to random mating (Hardy-Weinberg) proportions, only 7 of 587 variable loci studied in Yukon River chum salmon were significantly different, less than the number expected by chance (29): *ALAT* in the 1987 Toklat collection (χ^2 = 5.297/1 df); *sIDHP-2* in the 1987 Toklat collection (χ^2 = 10.228/3 df), the Bluff Cabin collection (χ^2 = 9.229/3 df), the 1987 Fishing Branch collection (χ^2 = 13.956/3 df), and the Big Creek collection (χ^2 = 9.922/3 df) collections; and *LDH-A1* in the Bluff Cabin (χ^2 = 7.085/1 df), and 1988 Sheenjek (χ^2 = 4.625/1 df) collections.

Statistical comparisons (multiple simultaneous G-tests) among fall-run chum salmon collections, using the loci and stocks in common between this study and that of Canada (Beacham et al. 1988), indicated no significant differences in allele frequencies among the collections from Minto (three years), Kluane (three years), Fishing Branch (four years), Teslin (two years), Toklat (four years), Delta (four years), Sheenjek (five years), and Chandalar (four years) collections. Only at a single locus (*mMEP-2*, Sheenjek River stock: G = 12.335/4 df;

P < 0.05) was a significant difference observed among data from stocks sampled in different years.

Data from 34 chum salmon collections, from both multiple sites of the same drainage and the same site in different years (Table 1), were pooled to form a 26-stock baseline data set. No significant differences ($p > 0.01$) were detected among chum salmon collections from different years from Salcha, Toklat, Delta, Chandalar, Sheenjek, and Fishing Branch Rivers. The two collections from the same site on the Anvik River (1987 and 1988) were significantly different genetically ($G = 55.820/15$ df; $P < 0.001$), and were not pooled prior to the analysis.

Two major groups were apparent in the dendrogram of genetic distances among the 26 Yukon River chum stocks analyzed: a summer-run group and a fall-run group (Figure 2). The Teslin and Kluane River stocks (fall-run fish) did not group closely with either temporal group or with each other. Within the summer-run group, two major subdivisions were apparent, those of the lower river (below river kilometer [rkm] 800) and those of the mid river (rkm 800 to 1150). The collections from the Gisasa River, which is a tributary of the Koyukuk River, might have been expected to group with other mid-river stocks of that drainage; however, that collection was genetically more similar to the geographically more proximate lower river stocks. Within the fall-run group, the Toklat, Delta, and Bluff Cabin stocks form a separate group. The other major group evident from the dendrogram includes two U.S. stocks (of the Chandalar and Sheenjek Rivers) joined with the remaining four Canada stocks, though a significant difference ($P < 0.05$) was observed between U.S. stocks

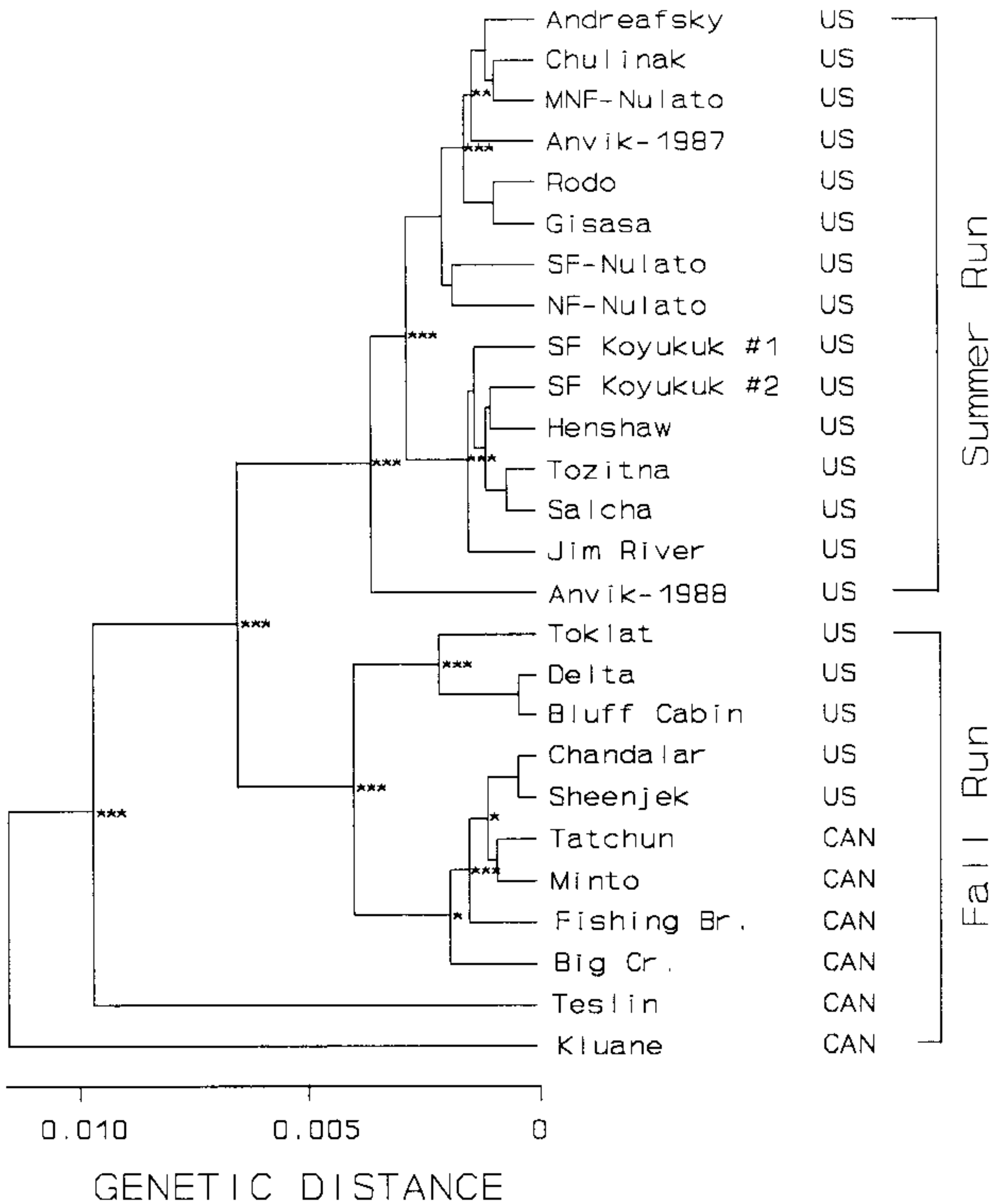

Figure 2. Dendrogram based on Nei's (1972) genetic distance showing the genetic relationship between stocks of Yukon River chum salmon. (US = United States, CAN = Canada). Asterisks designate significant branch points (* P < 0.05, ** P < 0.01, and *** P < 0.001).

and the Tatchun/Minto group. The Fishing Branch collection was significantly different ($P < 0.001$) from both the Chandalar/Sheenjek stocks and the Tatchun/Minto stocks, with the Big Creek collection significantly different ($P < 0.05$) than the others in the upper fall-run group.

Sequentially removing data for each stock prior to reanalyzing the relationships among chum salmon stocks resulted in one change in the order of grouping among summer-run stocks and one change among the fall stocks. With all 26 stocks in the analysis, the Anvik-88 stock was a separate branch grouped with the lower- and middle-river groups. Removing any one of Chulinak, Anvik-87, North Fork Nulato, Henshaw, Gisasa, Tozitna, or Salcha data sets from the analysis caused Anvik-88 to group with the lower river stocks, though still on a separate branch. For the fall-run stocks, when all 26 stocks were included, Kluane and Teslin grouped with neither the fall- nor summer-run stocks; these stocks were genetically divergent from all other stocks and from each other. When the Toklat River data set was removed from the analysis, the Kluane stock then grouped with the fall-run stocks, as a unique branch, while the Teslin stock remained separate from all other stocks.

Simulations

Simulations demonstrated that the maximum likelihood procedures accurately discriminated between summer-run and fall-run chum salmon stocks, but that the estimated proportion of U.S. and Canada fall chum salmon stocks were less precisely allocated. In the series of simulations testing the identification of summer- versus fall-run stocks, the estimated contribution of each run to the artificial mixture was included within one standard deviation of the actual value at all proportions tested except at the extremes, 0.0 and 100.0% (Figure 3). For the simulations testing the ability of the program to discriminate between U.S. and Canada fall chum stocks, the true proportion of each group in the artificial mixture was also within one standard deviation of the estimated value at all proportions tested except the extremes; however, the associated error terms were greater at each increment tested in the U.S. versus Canada simulations than the summer- versus fall-run simulations. The misallocation between summer-run and fall-run stocks was predominantly an overestimate, by 4.5 to 7.3%, of the proportion of summer-run stocks in the mixtures (Figure 4). A higher percentage of misallocation to summer-run stocks occurred when U.S. fall stocks were present at higher proportions because U.S. fall-run chum salmon stocks were more genetically similar to (U.S.) summer stocks than Canada fall-run stocks were to summer-run stocks.

Adjusting the relative stock contributions composing the artificial mixture for the simulations to reflect escapement size did not change the results substantially. Both sets of estimates were within one standard deviation of each other throughout the range of increments tested (R. L. Wilmot, unpublished data).

In the simulations (SIMOBS) where data from each of six fall-run test stocks were added incrementally to actual mixed-stock data (identified above as being composed of more than 99% summer stocks), the observed decrease in the proportion of summer-run fish identified was within 2 - 5% of the expected values as the contributions of Tanana River, Canada main-stem Yukon River, Kluane/Teslin Rivers, and a Canada fall-run stock mixture to artificial mixed-stock data sets were increased; in these four tests, little misallocation by the computer

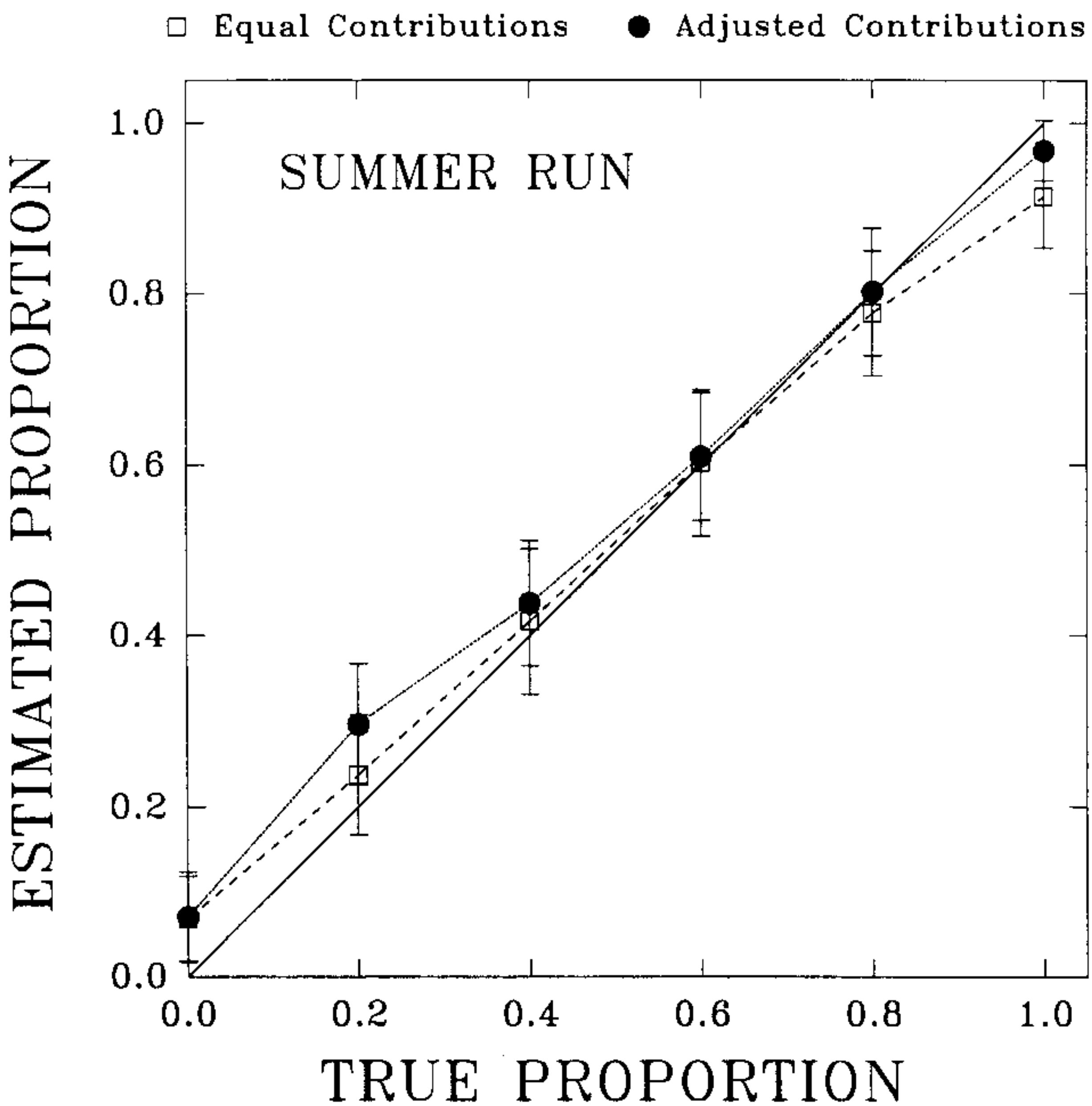

Figure 3. Estimated versus true proportion of fall-run versus summer-run chum salmon in the Yukon River. Estimates are the mean of 100 bootstrap resamplings, and error bars are one standard deviation around the mean. The clear squares represent the results when stocks are added in equal proportion and solid circles represent results when the stocks are added in proportion to their 1987-1990 escapement averages.

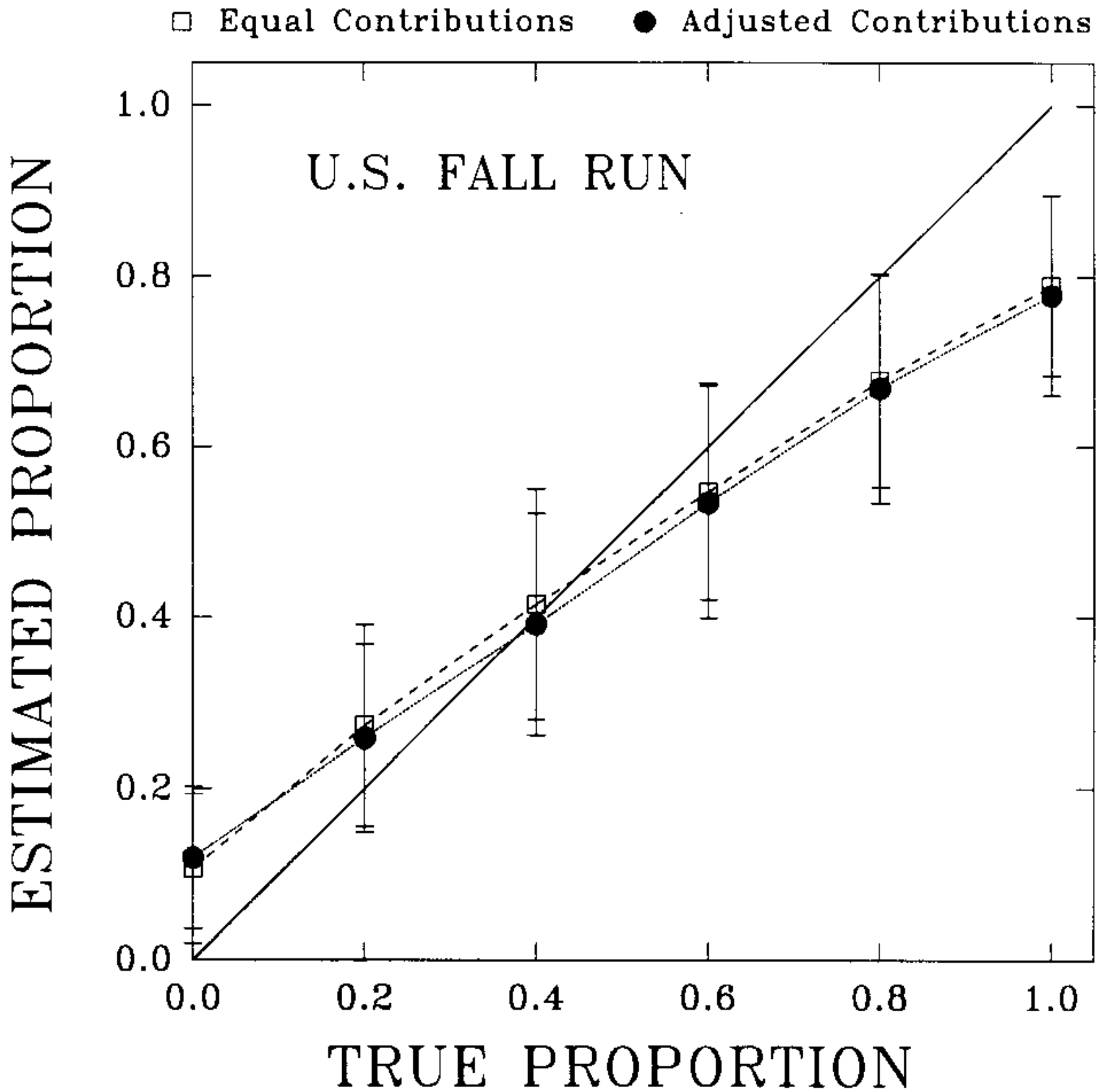

Figure 4. Estimated versus true proportion of United States and Canadian fall runs of chum salmon in the Yukon River. Estimates are the mean of 100 bootstrap resamplings, and error bars are one standard deviation around the mean. The clear squares represent the results when stocks are added in equal proportion and solid circles represent results when the stocks are added in proportion to their 1987-1990 escapement averages.

program of fall-run fish to summer-run stocks was observed (Figure 5). In the same series of simulations applied first to the Chandalar/Sheenjek stocks, then the Fishing Branch River stocks, the actual proportion of these fall-run stocks in the artificial mixtures was underestimated by as much as 25% over the range of increments tested; however, the misallocation from these fall run stocks was to other fall-run stocks, predominately to the Canadian mainstem stocks.

In the simulations where data from the Anvik and Koyukuk River (summer-run) stocks were added incrementally to actual mixed-stock data (identified above as being composed of more than 99% fall-run stocks), the proportion of fall-run fish detected in the mixtures decreased only slightly as the proportion of Anvik and Koyukuk River data was increased (Figure 6). The contributions to the artificial mixture of both of these summer-run stocks were consistently underestimated in the series of incremental simulations, but only up to 25% of the misallocated fish were assigned to fall-run stocks rather than to other summer-run stocks.

Stock composition estimates of commercial and test catch

Estimates of the stock composition of collections from District 1 commercial and test net fisheries indicated that, in all four years, the Yukon River lower river summer-run chum salmon stocks (of U.S. origin) contributed 75 - 100% of the catch until mid-July (Figures 7, 8; Appendices IX through XVI), and up to 42% of the catch for the rest of the fishing season. Less than 17% of the chum salmon sampled in June were allocated to fall-spawning stocks of the U.S. or Canada.

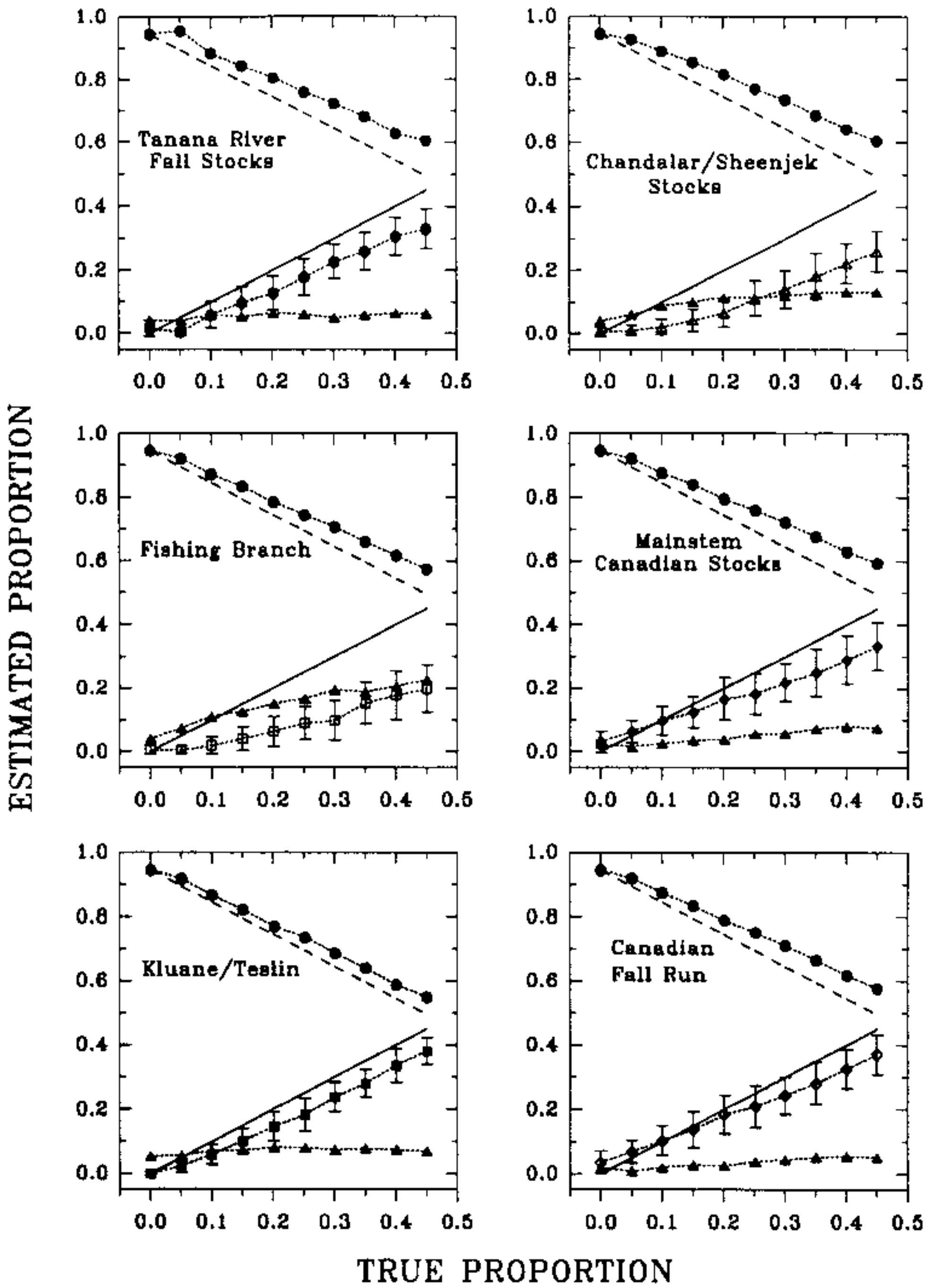

Figure 5. Results of the SIMOBS tests to determine the accuracy of estimates of fall run chum stocks in a mixture. Proportions of a known stock or stocks are added at 5% increments from 0 to 45%. The solid line represents 100% accuracy, and the error bars are derived from 100 bootstrap resamplings (▿ = Tanana, ▵ = Chandalar/Sheenjek, □ = Fishing Branch, ◆ = Canadian Mainstem, ■ = Kluane/Teslin, ◊ = total Canadian fall run, o = Summer-run stocks, and ▴ = remainder of fall run).

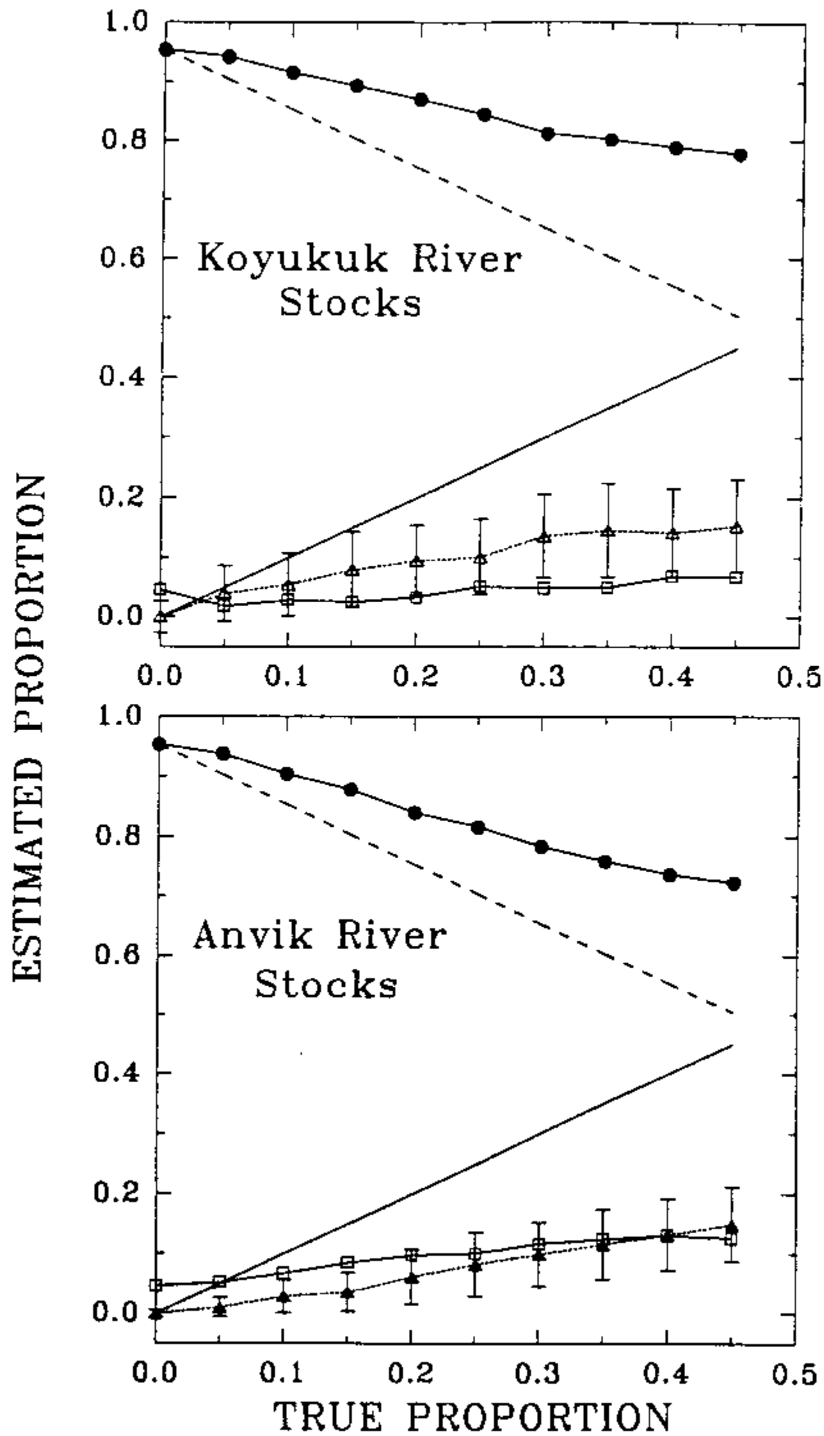

Figure 6. Results of the SIMOBS tests to determine the accuracy of estimates of two summer-run stocks in a mixture sample. Proportions of a known stock were added in 5% increments from 0 to 45%. The solid line represents 100% accuracy, and error bars are derived from 100 bootstrap resamplings (● = fall run stocks, □ = remainder of summer run, △ = Koyukuk stocks, and ▲ = Anvik stocks).

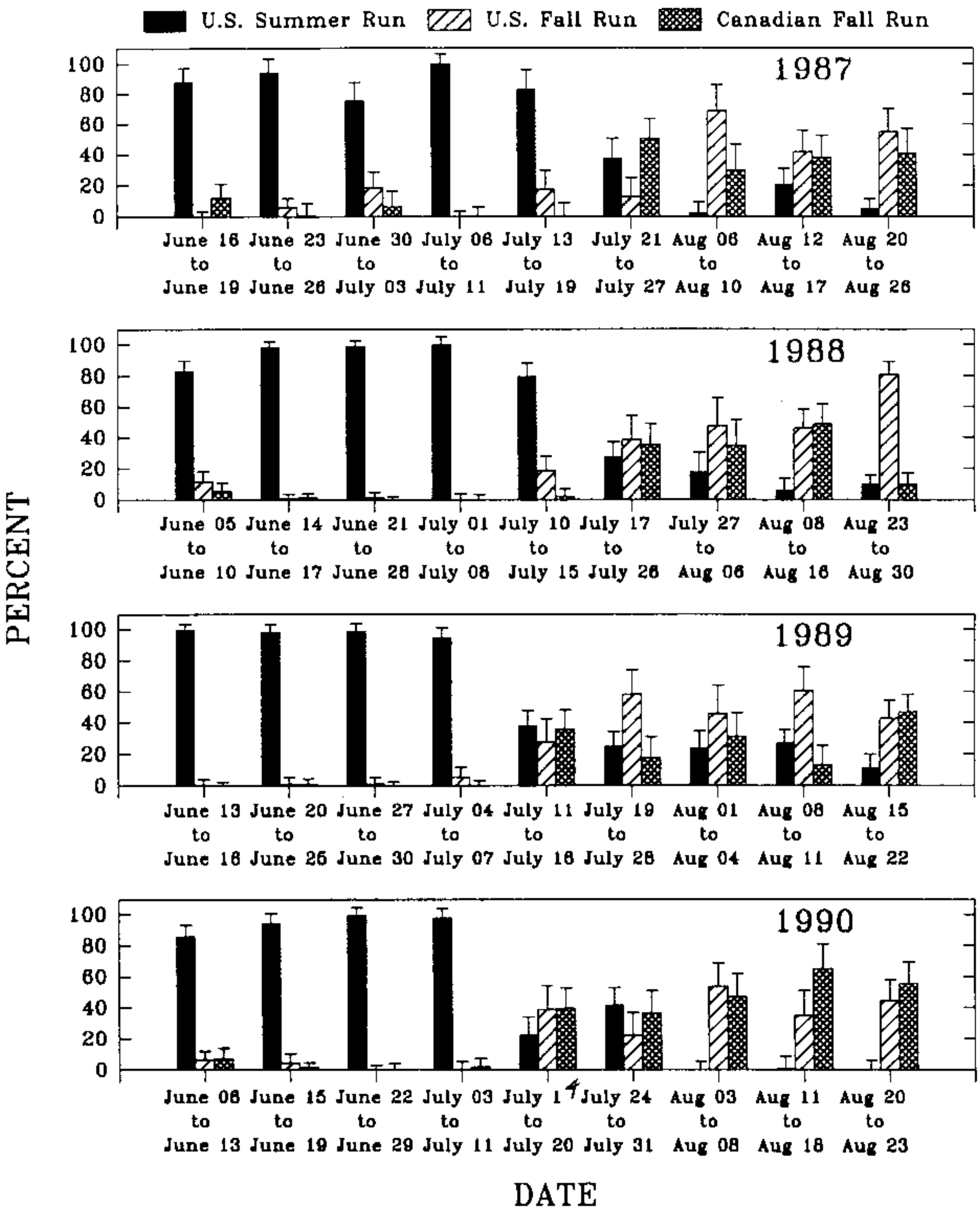

Figure 7. Percent of United States summer- and fall-run fish and Canadian fall-run fish caught in the Lower Yukon River chum salmon fishery (1987, 1988, 1989, and 1990). Error bars represent one standard deviation derived from 100 bootstrap resamplings of the baseline and mixture samples.

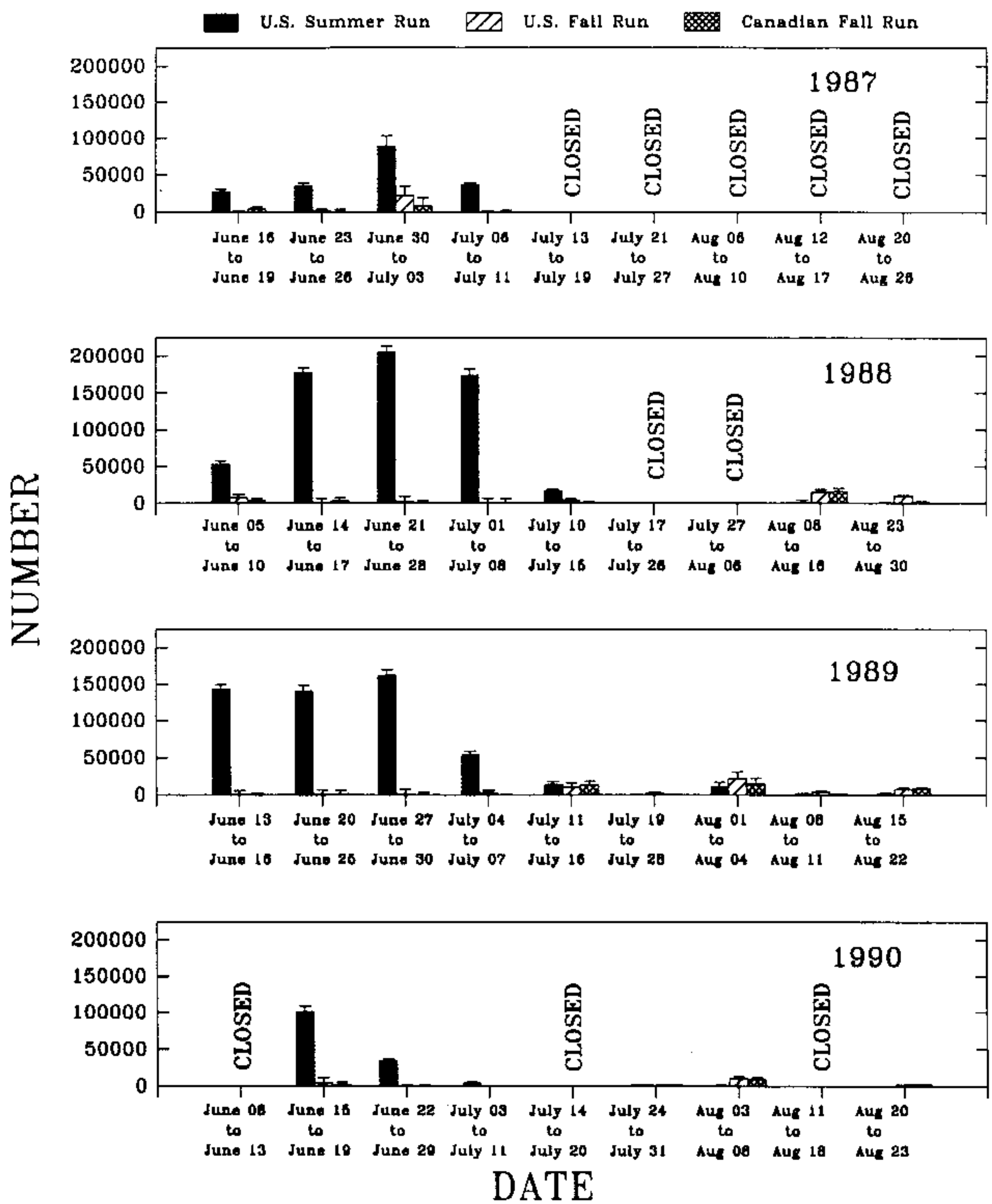

Figure 8. Number of United States summer- and fall-run fish and Canadian fall-run fish caught in the Lower Yukon River chum salmon fishery (1987, 1988, 1989, and 1990). Error bars represent one standard deviation derived from 100 bootstrap resamplings of the baseline and mixture samples.

While up to 11.9% Canada fall-run chum salmon stocks were identified in collections from District 1 as early as GSI Period 1 in 1987, no statistically significant contributions from Canada stocks were identified before an interval which ranged from July 11 - 14 over the course of the study. The proportions of Fishing Branch and main-stem Canada Yukon River chum salmon in the catch were highest during mid-July to mid-August. The timing of the maximum proportion of the catch sampled in District 1 that was attributed to Kluane and Teslin River stocks varied from year to year, occurring from mid-July in 1988 and 1990, to early August in 1989, and late August in 1987; the time period in 1990 that had the highest estimated proportion of Kluane/Teslin stocks, 20.4%, was not open to commercial fishing.

Excluding two early-season, statistically non-significant allocations, the Tanana fall-run stocks were responsible for 13.8 to 70% of the total catch from mid-July to the end of the fishing season. Whereas 17.7% of the catch in GSI Period 1 in mid-June, 1987 was identified as the Chandalar/Sheenjek stock, most statistically significant contributions by this stock group were made between mid-July and mid-August each year.

From 1987 to 1990, the composition of the total District 1 chum salmon catch ranged from 82.0 to 91.0% ($\bar{x}$ = 85.7 ± 5.8%) summer-run fish, from 5.7 to 10.6% ($\bar{x}$ = 8.6 ± 5.8%) U.S. fall-run fish, and from 3.3 to 8.2% ($\bar{x}$ = 5.7 ± 4.7%) Canada fall-run fish (Table 3). Of the proportion of chum salmon identified as fall-run stocks, 60.6% were of U.S. origin (range: 54.3 to 68.5%), and an average of 39.4% were of Canada fall-run origin. When these percentages were applied to the total number of chum salmon caught in District 1 during the four-year period of the study, the estimated number of summer-run fish ranged from 144,606

Table 3. Summary of the estimated contributions by origin to the fishery in District 1 for chum salmon - 1987 to 1990. Errors are one standard deviation. Percentages in parentheses are based on the fall-run totals only.

	1987		1988		1989		1990		Average	
Run	%	Number	%	Number	%	Number	%	Number	%	Number
					U.S.					
Summer	84.5±10.0	188,335±22,382	91.0±4.7	630,581±32,207	85.2±5.6	532,705±35,299	82.0±6.0	144,606±10,516	85.7±5.8	374,055±25,102
Fall	10.6±7.5 (68.5±48.2)	23,689±16,670	5.7±4.4 (62.5±48.7)	39,155±30,497	8.4±6.4 (56.9±43.0)	52,760±39,867	9.8±6.8 (54.3±37.8)	17,195±11,953	8.6±5.8 (59.9±44.7)	33,200±24,748
					Canadian					
Fall	4.8±9.0 (31.5±57.8)	10,874±19,986	3.3±3.4 (37.5±37.4)	23,466±23,440	6.4±4.6 (43.1±31.0)	40,043±28,739	8.2±4.9 (45.7±27.2)	14,447±8,621	5.7±4.7 (40.1±36.5)	22,208±20,198

to 630,581 ($\bar{x}$ = 374,055); the number of fall-run chum salmon of U.S. origin ranged from 17,195 to 52,760 ($\bar{x}$ = 33,200), and the number of Canadian-origin (fall-run) chum salmon ranged from 14,447 to 40,043 ($\bar{x}$ = 22,208) (Table 3). Error terms are the 4-year average of the one standard deviation errors on the yearly estimates. The standard deviations associated with the stock composition estimates in the early portion of the season, when the majority of fish are of the summer run and only a few fall-run stocks were present, ranged from 2.0 to 5.0%. Later in the season, when the genetically close fall-run stocks from near the border made greater contributions to the catch, the error terms associated with the estimated stock contribution estimates ranged between 10.0 and 15.0%. The estimated percentage of U.S. chum salmon stocks in the total catch from 1987 to 1990 ranged from 91.8 to 96.6% of the annual harvest.

Chinook Salmon

Relationships among stocks

Of 67 loci screened in Yukon River chinook salmon collections, 35 were variable and 21 met the criteria for GSI analysis; 22 loci were actually used in the analyses because variation at *TPI-1* was observed in the mixed-stock collections, though not in the collections from the tributaries used as baseline data. Of twenty-one loci (excluding *sMEP-2*, which was treated as a non-segregating character) tested for conformance to random mating (Hardy-Weinberg) proportions in 31 collections, only genotype proportions for 4 loci were significantly different than expected: *PEP-A* in the Andreafsky collection (χ^2 = 15.268/1 df), *sMEP-1* in the Jim

River (χ^2 = 55.643/3 df) and Henshaw Creek (χ^2 = 9.915/3 df), and *MPI* in the North Fork Nulato River (χ^2 = 10.349/1 df). In 377 tests of loci variable in 31 stocks, 19 loci are expected to be identified as significantly different by chance.

Statistical comparisons of allele frequency data from this study and that of Beacham et al. (1989) showed significant differences in allele frequencies among Canada Yukon River chinook salmon collections from different years and between collections representing different life history stages (adults versus juveniles). The data from Tatchun (1987, 1988, and 1989 adults), Nisutlin (1987 and 1989 adults), Blind Creek (1986, 1987, and 1989 juveniles), McQuesten River (1986, 1987, 1989, and 1990 juveniles), Takhini River (1986 and 1987 juveniles, 1988 adults), and Ross River (1987 juveniles, 1988 and 1989 adults) were significantly different ($P < 0.001$). The North Klondike collections (1986, 1987, 1989, and 1990 juveniles) were also significantly different ($P < 0.01$).

Data from the 31 collections in this study (Table 2, Appendix IV), including those from sites of the same drainage sampled in different years, were pooled to represent 20 stocks for estimating the genetic distance among stocks. Only between the collections from the Takhini River system were significant differences ($P < 0.01$) detected among data from the same stock sampled at the same site in different years. Data from the 1988 collections from the Takhini River adult chinook salmon differed statistically from the 1990 juvenile collections (G = 17.428/6 df, $P < 0.01$), due predominately to a single locus, *MPI-1*; the data were pooled in spite of the allelic differences at the *MPI* locus because the sample size in both collections was very small (N=26 in both 1988 and 1990). After pooling allele frequency data from chinook salmon stocks sampled in more than one year and pooling the Jim River data with that of the Henshaw Creek stock (because of data missing for one locus), a 20-stock baseline was used for calculating genetic distances among stocks and for mixed-stock analyses.

From the dendrogram showing the relationships among the 20 Yukon River chinook salmon stocks, two major groups were evident, corresponding to U.S. and Canada stocks (Figure 9). Among the U.S. stocks, a lower river group (below river km 800) and a mid-river group (between river km 800 and 1150) joined. As with chum salmon, the chinook salmon collection of the Koyukuk River tributary, Gisasa River, were genetically more similar to lower river stocks than to other Koyukuk River stocks. The Canada stocks were grouped as: McQuesten and North Klondike River collections (from near the U.S./Canada border); the Pelly River collections (from Ross River and Blind Creek); the Takhini River collections (from Stony Creek and main-stem Takhini River); and a group consisting of the remaining upriver stocks (except Takhini, and including the collections from Tatchun Creek, Little Salmon River, Bear Feed Creek, Big Salmon River, and Nisutlin River).

Sequentially removing data for each stock prior to reanalyzing the relationships among chinook salmon stocks resulted in four changes in the order of grouping on the dendrogram of genetic relationships: 1) removing McQuesten data from the analysis caused Klondike to group with U.S. stocks, but as a separate branch; 2) removing Ross River data from the analysis caused Blind Creek to group with U.S. lower Yukon stocks as a separate branch; 3) removing Takhini data from the analysis caused the Stony Creek stock to group with the Canada mid-river group; and 4) removing Stony Creek data from the analysis caused Takhini

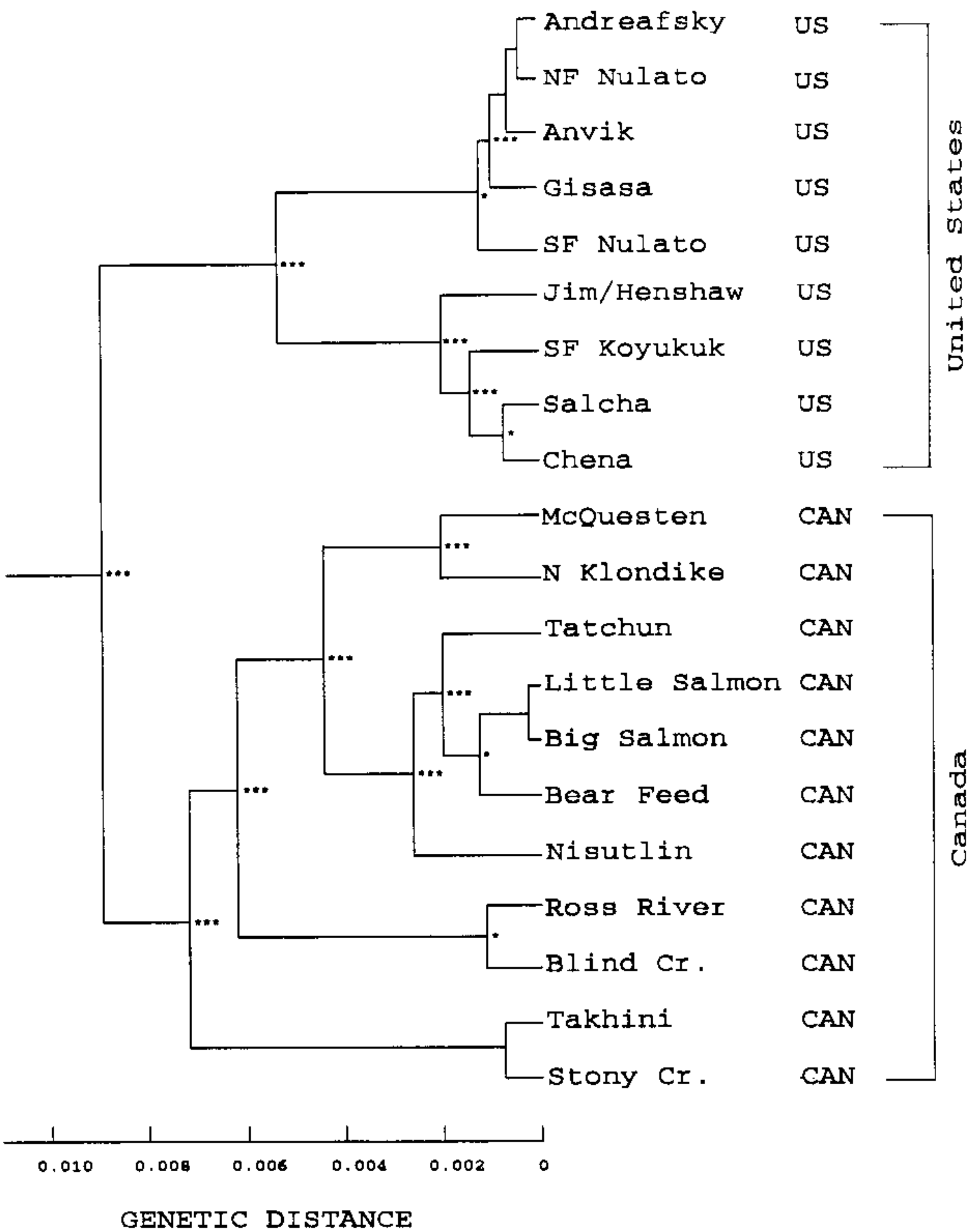

Figure 9. Dendrogram based on Nei's (1972) genetic distance showing the genetic relationship among stocks of Yukon River chinook salmon. Asterisks designate significant branch points (* $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$).

to become a branch, separate from both the U.S. and Canada groups.

Simulations

In simulations to determine the degree of accuracy in distinguishing between U.S. and Canada chinook salmon in mixed-stock collections, the expected and estimated proportions of U.S. and Canada stocks were within one standard deviation of each other at all increments from 0 to 100% whether the simulations were done using equal proportions of each baseline to create the mixture, or using stock sizes proportional to escapement estimates (Figure 10). The proportion of either group (U.S. or Canada) was overestimated at low contributions, and underestimated at high proportions. The standard deviations of the estimates ranged from 1 to 6%.

Stock composition estimates of commercial and test catch

Estimates based on mixed-stock analyses indicated that, in all four years, the Yukon River chinook salmon stocks of Canada origin contributed more than 50% of the catch until mid-June (Figures 11, 12; Appendices XVII through XXIV). During the early part of the season, the Pelly River stock was the largest contributor to the catch, followed by the Big Salmon River, and the Tatchun Creek stock. After mid-June, the U.S. stocks were responsible for more than 50% of the catch. The Nulato River stocks contributed the most U.S. fish to the District 1 catch, followed by the stocks of the Koyukuk River system. Besides the stocks listed above, the contributions of any one stock of either Alaska or Canada averaged less than

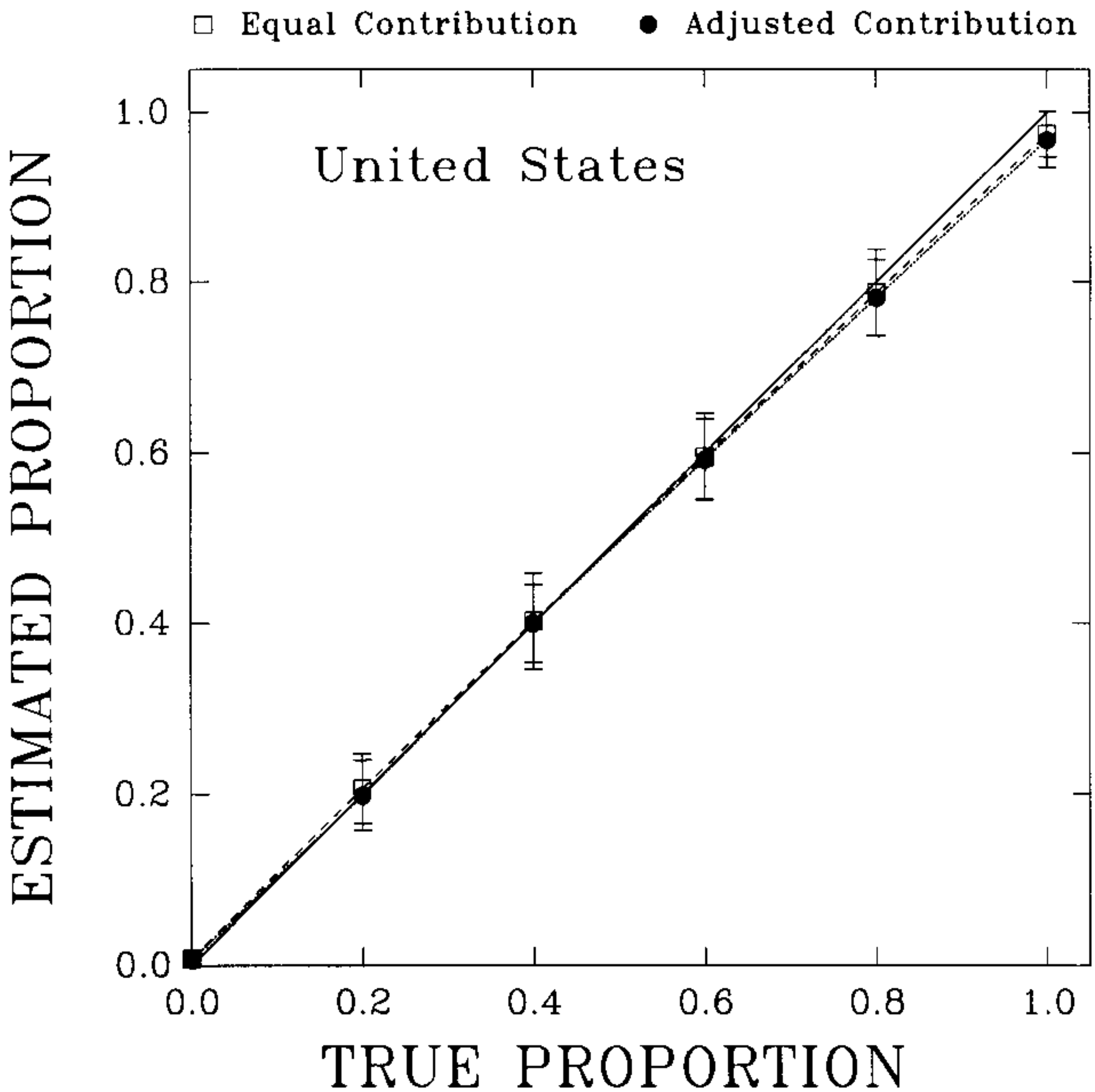

Figure 10. Estimated versus true proportions of United States and Canadian stocks of Yukon River chinook salmon. Estimates are the mean of 100 bootstrap resampling, and error bars are one standard deviation around the mean.

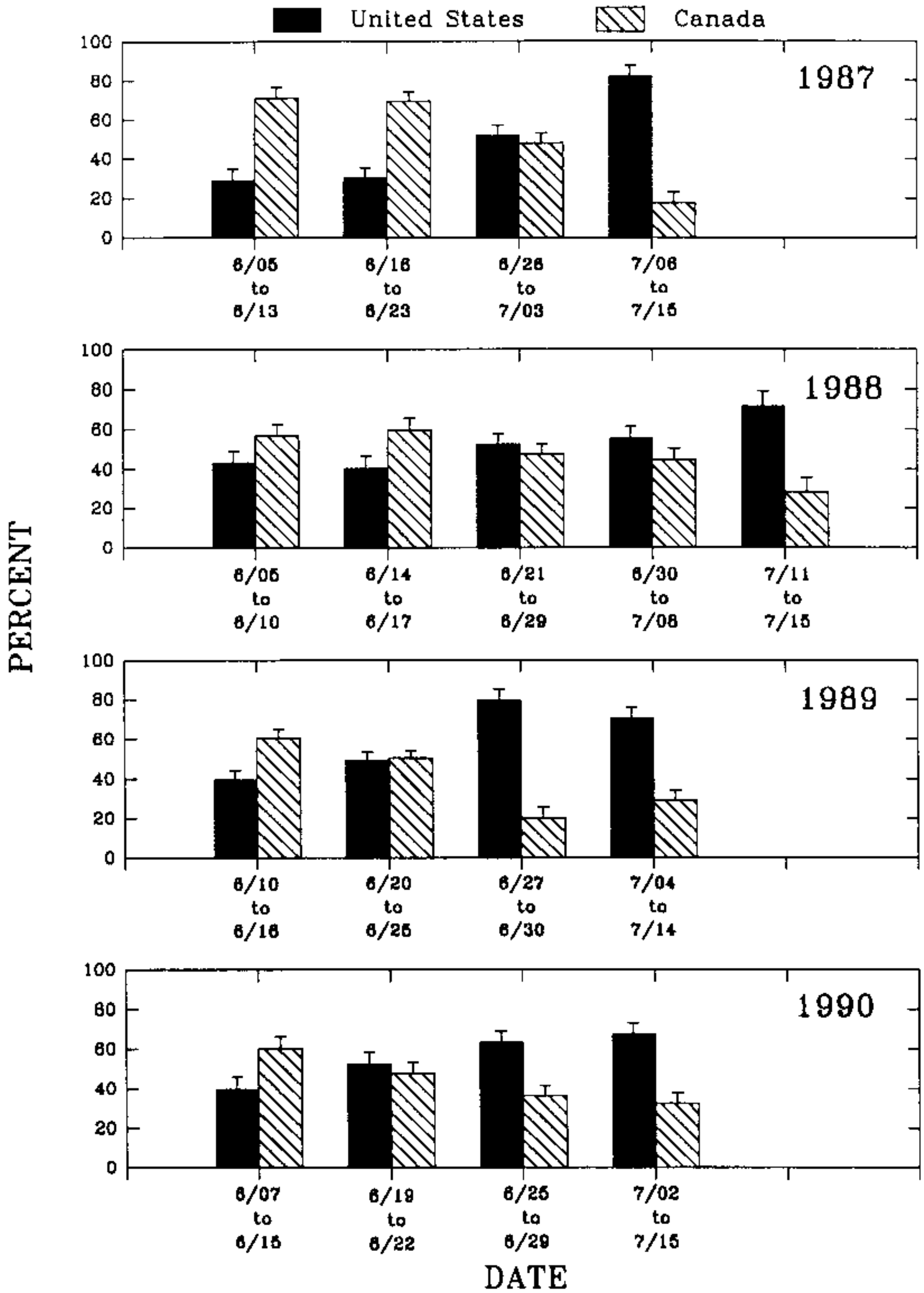

Figure 11. Percent of United States- and Canadian-origin chinook salmon caught in the Lower Yukon River fishery (1987, 1988, 1989, and 1990). Error bars represent one standard deviation derived from 100 bootstrap resamplings of the baseline and mixture samples.

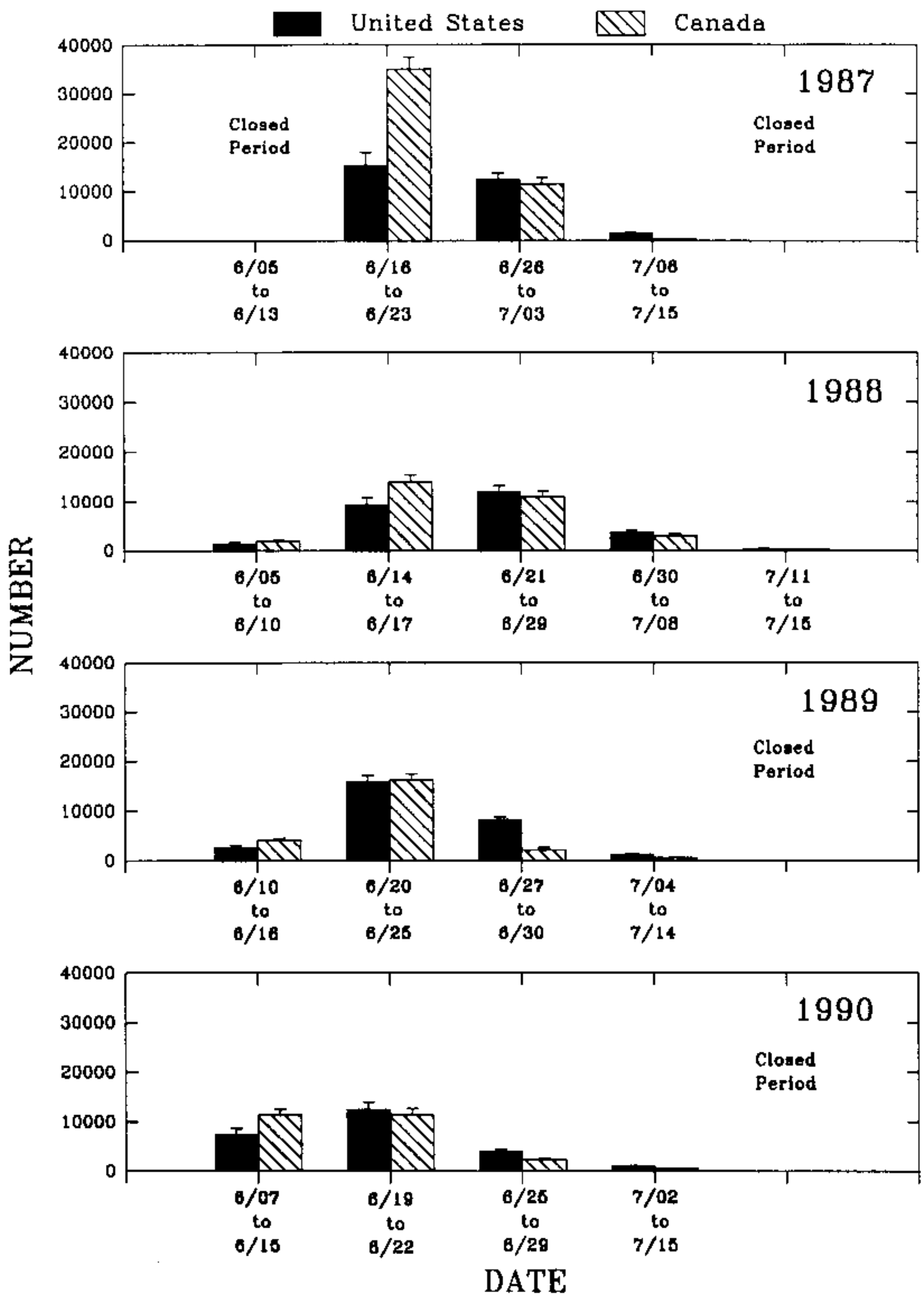

Figure 12. Number of United States- and Canadian-origin chinook salmon caught in the Lower Yukon River fishery (1987, 1988, 1989, and 1990). Error bars represent one standard deviation derived from 100 bootstrap resamplings of the baseline and mixture samples.

5.0% of the total catch in all years and during all sampling periods.

From 1987 to 1990, U.S. chinook salmon stocks comprised from 38.7 to 55.1% ($\bar{x}$ = 46.8 ± 5.1%) and from 44.9 to 61.3% ($\bar{x}$ = 53.2 ± 5.1%) Canadian origin stocks of the fish harvested in District 1 (Table 4). In numbers, the U.S. chinook salmon harvested ranged from 25,374 to 29,648 ($\bar{x}$ = 27,623 ± 3,012) and Canada chinook salmon from 23,046 to 46,993 ($\bar{x}$ = 31,419 ± 3,012).

Table 4. Summary of the estimated contributions by origin to the fishery in District 1 for chinook salmon - 1987 to 1990. Errors are one standard deviation.

	1987		1988		1989		1990		Average	
Run	%	Number	%	Number	%	Number	%	Number	%	Number
U.S.	38.7±5.0	29,648±3,805	47.6±5.5	27,148±3,115	55.1±4.3	28,322±2,194	49.7±5.7	25,374±2,932	46,8±5.1	27,623±3,012
Canadian	61.3±5.0	46,993±3,805	52.4±5.5	29,941±3,115	44.9±4.3	23,046±2,194	50.3±5.7	25,694±2,932	53.2±5.1	31,419±3,012

DISCUSSION

Management of mixed-stock fisheries, especially of a multi-national origin, requires a method of accurately identifying the components of the catch. For stock composition estimates to be accurate and precise enough to meet management needs, the level of quantifiable genetic differences among stocks or stock groups must be sufficiently high. Four years of genetic data from Yukon chum and chinook salmon baseline and mixed-stock samples allowed us to determine the genetic relationships among stocks, the estimated composition of the District 1 harvest by country-of-origin, the run-timing of stocks or stock groups through District 1, the levels of precision and accuracy of the estimates, and the strengths and limitations of the data sets using computer simulations. We also compared our results to previous studies and made conclusions about the overall utility of the genetic stock identification method in the management of Yukon River salmon stocks.

Chum Salmon

To build on the previous chum salmon genetic study by the Canadian Department of Fisheries and Oceans, the scope of Yukon River chum salmon was expanded to include larger sample sizes for the genetic baseline data set and for mixed-stock collections from the fishery; add more genetic characters to the analyses; sample summer-run as well as fall-run chum salmon stocks and fisheries; and add more consecutive years of data.

Relationships among stocks

No evidence was found that any of the 34 chum salmon collections from Yukon River tributaries was composed of a non-random group of individuals. Individual loci not in random mating (Hardy-Weinberg) proportions were observed in a few stocks, but no significant differences from those expected were observed when all loci for each stock were considered. Collections not in random mating (Hardy-Weinberg) proportions can indicate 1) non-random sampling; 2) inclusion of more than one population in a collection; 3) disproportionate survival of certain genotypes (selection); or 4) chance inclusion of genotypes disproportionate to their presence in the population studied. Though the statistics used to test for these problems are not highly sensitive to small differences among stocks in relatively small sample sizes (Waples and Smouse 1990), lack of deviations from random mating proportions provides some confidence in use of these collections for baseline data for mixed-stock analyses.

The observed stability of allele frequencies from year to year in Yukon River chum salmon collections demonstrated that baseline data can be used for mixed-stock analysis for more than one year without resampling. Of the Yukon River chum salmon populations sampled (this study; Beacham et al. 1988), statistically significant divergence in gene frequencies between collections from the same site made in different years was rare. Only two summer-run collections, taken from the Anvik River in July of 1987 and 1988, were significantly different. The Anvik River is a large, productive river system that likely supports numerous spawning stocks in headwater tributaries, plus an unknown quantity of mainstem spawners.

For logistical reasons, the collections were made at a mainstem sonar site, which is undoubtedly a migratory corridor for upstream spawners of several populations. Since most studies of salmonid population genetics support temporal stability in allele frequencies between multiple collections from the same location (e.g., Grant et al. 1980, Beacham et al. 1987), different combinations of upriver, genetically distinct stocks most likely were included in the Anvik River mainstem collections made in 1987 and 1988.

Analyses of the genetic relationships among chum salmon stocks demonstrated that Yukon River summer-run stocks and the fall-run stocks have diverged genetically (Figure 4). These two runs correspond roughly to geographic lower-river (summer-run) and upper-river (fall-run) stocks, and middle-river stocks with both summer- and fall-run fish. However, not all the fall-run chum salmon stocks of the U.S. and Canada were sufficiently genetically distinct from each other for accurate stock identification. The Tanana River stocks (excluding summer-run Salcha) were genetically distinct from the upriver fall-run stocks. The Kluane and Teslin River stocks were distinct from all other stocks and from each other. However, problems in stock discrimination among the other fall-run group, which includes the Chandalar and Sheenjek stocks of the U.S., and the Fishing Branch and upper Yukon mainstem collections of Canada, can be anticipated due to their close genetic relationship.

Simulations

Simulations of stock composition analyses demonstrated the strengths and limitations of the chum salmon genetic baseline data set and the stock identification method for certain cases.

Using these baseline data, the maximum likelihood program was able to discriminate accurately between Yukon River summer-run and fall-run chum salmon stocks with little bias. However, the estimates of the relative contributions of U.S and Canada fall-run chum stocks were not as accurate, and were biased at extreme values, e.g., when the actual contribution were near 0 or 100%. This type of bias is typical (Jerome Pella, NMFS, unpublished manuscript), and the known direction of the bias can aid in interpretation of actual mixed-stock contribution estimates. At high or low proportions the estimates of the proportion of U.S. or Canada fall-run stocks may be under or overestimated if the contributing stocks are not genetically distinct.

The bias at extreme values observed in the simulations means that the small estimated proportions of fall-run fish observed during the early summer fishing periods may be either 1) statistical artifacts, or 2) real, as some the stocks identified (e.g., Kluane and Teslin River) were genetically distinct from the other stocks sampled. In the mixed-stock collections from late July through August, the observed stock group contributions for U.S. and Canada fall-run stocks were usually not near 0 or 100%, so this type of bias was not an issue during this period.

The levels of accuracy and precision observed in the simulations of stock identification of fall-run chum salmon stocks suggest that individual stock contribution estimates were not accurate or precise with the exceptions of genetically distinct stocks like those of the Kluane or Teslin Rivers. The estimates from the GIRLSEM and the bootstrap resampling methods were not close until individual stock allocations were summed into the six major stock groupings (Appendices IX to XVI). The standard deviations observed using either of these two methods of analysis were equal or nearly equal to the associated estimates unless the estimates were summed by stock groups. This approach has been recommended by several authors (Milner et al. 1981, Millar 1987, Pella and Milner 1987, Wood et al. 1987).

The estimated proportions of four of the fall-run stock groups (Tanana River stocks, excluding the summer-run Salcha River stock; Kluane and Teslin River stocks; Canada mainstem stocks; and a composite of all Canadian fall-run stocks) were underestimated by less than 10% in the simulations that added fall-stock data to a predominately summer-run mixed-stock data set (Figure 5), indicating that these stocks were genetically distinct from each other. The Chandalar/Sheenjek (U.S.) and Fishing Branch (Canada) stocks were not as distinct genetically, and both of these stock groups misallocated to Canada mainstem stocks.

This misallocation may be related to how the mainstem baseline samples were collected. The Minto and Tatchun collections were taken from Canada mainstem and slough habitats, and Big Creek is a short mainstem tributary. Because these sites were sampled so close to the main river, conglomerations of upstream migrants may have inadvertently been included in the collections. Use of composites of multiple stocks can result in an indistinct average mixed-stock baseline data set rather than a discrete stock (Shaklee 1991), possibly explaining some of the observed misallocation to mainstem stocks from other fall-run stocks, including Fishing Branch and Chandalar/Sheenjek.

In a series of simulations with data from summer-run stocks added in known proportions to a predominantly fall-run mixed-stock collection, the contributions of the two summer-run stocks (Anvik and Koyukuk) most often observed during the mid-July through late August time period were consistently underestimated, with misallocation to fall-run stocks (except Kluane and Teslin stocks). These results suggest that some of the contribution of fall-run stocks to the late July and August catch may be overestimated at the expense of summer-run stocks. The simulations to test the overall ability of the program to discriminate between summer-run and fall-run stocks that showed an overestimation of summer stocks at proportions 0 to 50% may be true in general, but may be contradicted when certain individual stocks are in the catch. Future studies may show that misallocation between certain summer-run and fall-run stocks reflect actual genetic similarities between fall-run stocks and certain late summer-run stocks, e.g., the upper Koyukuk River system. Overall, the simulations indicate that 1) summer-run and fall-run chum salmon stocks can be accurately identified, 2) the proportion of U.S. fall-run stocks was underestimated due to misallocation of Chandalar/Sheenjek stocks to mainstem Canadian stocks, and 3) the proportion of summer-run stocks in the District 1 catch during mid-July through August was probably underestimated due to misallocation of certain summer-run stocks to fall-run stocks.

Stock composition estimates of commercial and test catch

Four years of stock composition estimates generally corresponded with what was known about run-timing of the Yukon River chum salmon stocks in the lower river. Both historical data and genetic analyses of collections of chum salmon from District 1 have demonstrated the predominance of the numerically greater lower river stocks in the early season, followed by predominantly upriver stocks. The date when fall-run fish become proportionally dominant varied from July 7 to July 21 over the four years. Part of the observed variability in timing of the summer- and fall-run components was likely due to the way commercial and test fishing periods were set (when the samples were taken), and how data for genetic stock identification periods were pooled to accumulate an adequate sample size. The remainder reflects the natural variability in timing of seasonal and stock components of the Yukon River chum salmon run. Our data indicated that a small proportion of the catch (less than 12%) in the lower river during June were fall-run stocks, and that the summer-run component remains significant through all of August. In three of the four years (1987 to 1989), a significant portion of the run entering the lower river throughout August was identified as summer-run fish, mainly from the Koyukuk River. A late season chum salmon run has been documented in the upper Koyukuk (Ken Troyer, USFWS, personal communication), supporting the stock composition estimates observed. A tagging study conducted from 1976 to 1978 showed that upper Yukon River fall chum salmon entered the river before the fall-run Tanana stocks (Buklis 1981). Our data show the Tanana River fall stocks entering the river in late July, the Chandalar/Sheenjek and Fishing Branch/Canadian mainstem stocks in mid July, and the Kluane/Teslin stocks arriving from mid to late July.

Based on estimates from this study of four years of mixed-stock analysis of the District 1 Yukon River fishery sampled during June to August each year, the total catch averaged 374,055 (85.7%) U.S.-origin summer-run chum salmon; 33,200 (8.6%) U.S.-origin fall-run chum salmon, and 22,208 (5.7%) Canadian-origin fall-run chum salmon. Of the total catch allocated to fall-run chum salmon, 59.9% were U.S.-origin fish and 40.1% were Canada-origin fish.

In the previous genetic stock identification study, limited to the fall fishing season from mid-July to late August each year, the estimates of the proportions of the 1985 and 1986 District 1 commercial harvest of Canada origin ranged from 18 - 90% of the chum salmon sampled weekly or bi-weekly (JTC 1988). The average proportion of Canada fall-run stocks in the nine collections made during those two seasons were 37.5% in 1985, and 60.6% in 1986.

In our study, the average estimates of the contribution of Canada chum salmon stocks to the District 1 harvest during the fall season for four years were weighted by catch, and included only the periods that were open to fishing. Thus, the four-year average of Canada-origin chum salmon in the fall season catch was 38.7%. This value was not directly comparable to the DFO study results for 1985 and 1986, which were not weighted by catch figures.

Also, the presence of summer-run fish in the fall season was not accounted for in the DFO study, which used only fall-run stocks in their genetic baseline data set. Our stock composition simulations showed that the actual number of U.S. chum salmon in the lower river harvest during the fall season was probably underestimated because some summer-run stocks were misallocated to fall-run stocks. In addition, some of the periods with high proportions of summer-run stocks during the four years of this study were closed to fishing, and were not represented in the four-year fall season stock composition estimate. Therefore, proportions of the catch allocated to Canada stocks using numbers of fish for 1987 - 1990 did not reflect the true proportion of the total fall season run that was of summer-run origin, but instead represented the proportions of the commercial catch (during open periods) of Canada origin during those years. Computer simulations also showed that (U.S.) Chandalar/Sheenjek stocks misallocated to Canada mainstem stocks, causing another source of underestimation of the U.S. component of the fall-run fishery.

Differences in the results between this study and those of DFO were probably also related to the number of genetic characters used in the analyses and the sample size of the mixed-stock collections. Seven protein loci were used in the DFO analyses compared to 19 in this study. Simulations comparing the same 7-locus data set used by DFO to a 22-locus chum salmon data set for stock identification in Washington and British Columbia showed lower discriminatory power with fewer genetic characters in the analysis (Shaklee 1991). Also, the sample sizes used for the 1985 and 1986 chum salmon mixed-stock fisheries collections were less than 114 fish for each period. Possibly due to the small sample sizes, a 95% confidence interval around the DFO estimates of the proportion of Canada chum salmon in the catch included zero in four of the nine sampling periods studied over two years.

The limitations of our study of the Yukon River chum salmon stock composition estimates for 1987 - 1990 were: under-representation of subpopulations (e.g., Anvik River stocks, and late-run lower and middle Yukon River stocks) in the genetic baseline data set; only 12 loci in 1987 analyses; combining data from commercial and test catch in GSI periods; combining data from different fishing periods; combining data from samples caught with different types of fishing gear; and possible non-random sampling of the District 1 catch.

In general, the concurrence between what is known about Yukon River chum salmon run timing and the genetic stock identification results indicated that the estimates of stock composition in the lower river are credible. Simulations demonstrated accurate and precise discrimination between summer-run and fall-run chum salmon stocks, but less power in separating U.S. and Canada fall-run stocks. Chandalar/Sheenjek and some summer-run stocks misallocate to other fall-run stocks, suggesting that both these U.S. stock groups may be underestimated during in the fall fishing season. Simulations demonstrated that discrimination among stock groups were accurate, but allocations to individual stocks were imprecise with this data set. More genetic characters to describe each stock and larger sample sizes in mixed-stock collections would improve the estimates. An assumption of the GSI model is that all stocks contributing to the fishery are represented in the baseline data set. Therefore, unsampled stocks, such as the Anvik River tributary stocks and late-run stocks in lower and middle Yukon River area, should be sampled for analysis.

Chinook Salmon

Relationships among stocks

The number of loci used in the chinook salmon analyses that did not conform to random mating (Hardy-Weinberg) proportions was less than the number expected by chance alone. Stability in allele frequencies between collections made in different years was observed in this study, except the two Takhini River collections (1988 and 1990). However, the size of the collections made in both years was small and the differences between data sets were due to a single locus. We therefore pooled the data for these two collections.

Statistical comparisons between data from this study and those of Beacham et al. (1989) of stocks common to both studies demonstrated genetic differences among several collections. Most of the collections where differences were detected were comprised of juveniles. Juveniles are difficult to sample due to the ease of including family groups rather than a random sample of a population, and because chinook juveniles in particular are known to migrate extensively among freshwater tributaries and to mainstem locations (e.g., Murray and Rosenau 1989). Allelic frequencies derived from juveniles may not be representative of the returning adult population (Allendorf and Phelps 1981), but multiple juvenile collections are probably a better representation of the entire run than a single collection would be (Robin Waples, NMFS, personal communication). The Takhini River drainage, like several of the other upper Yukon River drainages, is a large system with several lakes which could support several populations in the type of lake-outlet habitat often inhabited by chinook salmon. The differences among Takhini River chinook collections observed may relate to having sampled from different populations from mainstem and tributary sites. However, the observed level of differentiation among collections from within each major river system was less than the magnitude of the differences among stocks of different major river systems.

Data from all the collections that came from different sites of the same major Yukon River tributary typically could be pooled, as collections from the same tributary were not statistically different. One exception was the collection from the large and complex Koyukuk River drainage. The Gisasa River collection was genetically similar to the lower Yukon River stocks, whereas the collections from the Jim River, Henshaw Creek, and South Fork Koyukuk River were more closely allied genetically to mid-river stocks. Chinook salmon samples from Jim and South Fork Koyukuk Rivers were tried as a standard in stock composition studies using scale pattern characteristics because in analysis of variance tests using run of origin data for age-1.4 fish, scale variable in samples from the Jim and South Fork Rivers taken in 1986 suggested distinction from other Alaskan escapement samples (Merritt et al. 1988). Though misclassification to lower and upper river groups and the lack of precision in the estimates made Jim and Koyukuk stocks too indistinct to be useful for scale pattern analysis, the differences correspond roughly to the pattern also observed in the genetic relationships measured. The confluence of the Koyukuk and Yukon Rivers is geographically between the lower and middle river regions, but spawning chinook salmon populations in the upper Koyukuk are nearly as far from the Yukon River mouth as is the U.S./Canada border. The genetic divergence between the upper Koyukuk River stocks and the lower river stocks may be related to the geographic distance, e.g., due to reproductive isolation, founding events, or different selection pressure.

Genetic distance relationships observed among the Yukon River chinook salmon stock groups studied (Figure 5) corresponded generally to the geographic groups (lower, middle, and upper river) used for stock composition studies using analysis of scale patterns. Again, the exception was that, using genetic methods, the upper Koyukuk stocks grouped with the middle river stocks rather than the lower river stocks. As the lower and middle river runs correspond to the stocks of the United States, and the upper river run includes only Canada stocks, allocations of the lower river harvest of chinook salmon to the U.S. and Canada should be both accurate and precise.

Simulations

The simulations to test the ability of the maximum likelihood method to separate U.S. and Canada stocks indicated that the estimates of the contribution of Yukon River chinook salmon stocks to mixed-fishery collections were both accurately and precise by country-of-origin. Some individual stocks were genetically too similar to place a high degree of confidence on contribution estimates to the fishery. Six major stock groups, apparent from the dendrogram (Figure 9), were genetically distinct enough to provide acceptable precision in stock allocations.

Stock composition estimates of commercial and test catch

From 1987 to 1990, U.S. chinook salmon stocks comprised from 38.7 to 55.1% ($\bar{x}$ = 46.8 ± 5.1%) of the fish harvested in District 1. In numbers this corresponds to a four-year average of 27,623 ± 3,012 U.S.-origin chinook salmon, and 31,419 ± 3,012 Canada-origin chinook salmon. As with chum salmon, not all chinook salmon stocks were identified as contributing to the fishery every year. However, every stock was identified as a significant contributor to the fishery in at least one of the four years studied.

Analyses of scale patterns to make stock composition estimates has been more successful with chinook salmon than with chum salmon of the Yukon River drainage. Stock composition estimates for the District 1 chinook salmon catch have been made since 1980 by region of origin (McBride and Marshall 1983, Wilcock and McBride 1983, Wilcock 1984, 1985, 1986, Merritt et al. 1988, Merritt 1988, Wilcock 1990). Scale pattern classification accuracies for lower, middle, and upper Yukon River chinook salmon have been high (e.g., 0.965, 0.758, and 0.779 for the age-1.4 1986; Merritt et al. 1988). The upper Yukon River stock group identified using this method corresponds to Canada stocks.

Estimates of the stock composition of chinook salmon samples from the District 1 catch from 1987 to 1990 made using analysis of scale patterns were within a 95% confidence interval of the estimates made using genetic methods. Using scale pattern analysis, the estimated proportion of the catch of Canada origin were: 51.0% in 1987 (age-1.4 only: Merritt 1988); 53.8% in 1988 (Wilcock 1990); 47.0% in 1989 (Schneiderhan and Wilcock 1992); and 51.0% in 1990 (Schneiderhan, personal communication). The corresponding estimates, using genetic stock identification methods (this study), of the proportion of Canada-origin stocks in the catch were: 61.3% for 1987, 52.4% for 1988, 48.9% for 1989, and 50.3% for 1990.

The applicability of genetic methods to Yukon River chinook salmon stock identification in the lower river was supported by the accuracy and precision of U.S. and Canada allocations demonstrated by computer simulations, and by the correspondence of these genetic data with the estimates from analysis of scale patterns. Additional collections to represent unsampled populations should be analyzed, particularly from the Canada Yukon River tributaries, for which mainstem collections were frequently used. Larger sample sizes from the District 1 catch would increase the precision of the estimates and therefore the utility of the data.

CONCLUSIONS

The GSI methodology has been extensively used and evaluated for the Lower Columbia River chinook salmon fishery, the coastal Washington chinook salmon fishery, and the Puget Sound chum salmon fishery (Shaklee et al. 1990b). A large proportion of hatchery fish contribute to the harvest in all of the above fisheries, and because they are marked with coded wire tags, allow an alternative estimate of stock contribution to these fisheries. Acceptable levels of accuracy and precision for management of mixed-stock fisheries have been established for GSI estimates by blind tests (Milner et al. 1981), and computer simulations (e.g., Pella and Milner 1987, Wood et al. 1987, Shaklee 1991).

Based on the results of this study, the usefulness of the GSI methodology for management of Yukon River chum and chinook salmon stocks was evaluated. The utility of the method is based to a large degree on the level of discrimination required for management purposes. If the question is "what is the relative magnitude of summer- and fall-run stocks, or U.S. and Canada stocks in the mixed-stock fishery?" simulations demonstrate that the stock composition estimates are within ±15% (one standard deviation) for chum salmon and ±8% for chinook salmon. Stock composition estimates through the District 1 fishing season (June-August) show the proportional change from predominately summer-run to fall-run stocks. A small proportion of chum salmon caught in June were identified as fall-run stocks, and a statistically significant proportion of the chum salmon sampled in August were from summer-run stocks. Some problems exist in estimating the contribution of U.S. fall-run fish and Canadian fall-run fish to the District 1 fishery were due to the relatively close genetic affinity between the Chandalar/Sheenjek, the Fishing Branch, and the Canadian mainstem stocks. On the other hand, the close agreement between the two independent estimates of stock contribution to the chinook salmon fishery by scale pattern analysis and by GSI helps establish considerable validity to these estimates.

Estimates of mixed-stock composition below these levels of discrimination must be viewed with caution. The error on estimates of contribution of the six major stock groups in chum salmon can run as high as ±20% and up to ±10% in chinook salmon. At this time, the error terms on estimates of individual stocks for both species are too large and should not be used until the baseline data set is expanded.

The current baseline for both chum and chinook salmon is adequate for estimates of contributions of U.S. and Canadian stocks in the fishery. Additional genetic characters in the baseline data set would improve the accuracy and precision of the estimates and could eventually lead to the capability to make estimates of contributions by individual stocks. Other improvements would include larger sample sizes, making sure that samples are taken over the entire course of the run, and insuring that all major contributing stocks are included in the baseline data set. Estimates could also be improved by insuring the mixed-stock fishery sample is as large as feasible (300 fish per time period), and that the collection represents a random sample of the fishery. Future analyses will address questions regarding pooling data from fish caught by different gear types, and pooling data from fish caught in test and commercial catch. In the future, GSI methods should be applied to the fisheries that occur in the other fishing districts.

Adding more genetic characters to the baseline data mixture sample can potentially increase the resolution to acceptable levels for estimates for individual stocks. For example, using the current 19 loci baseline for chum salmon, we cannot discriminate between the early and late run South Fork Koyukuk River samples. Recently, we have been able to resolve a total of 33 variable loci for these two collections, and the genetic differences between these stocks were significant. Preliminary results with mtDNA analysis for both Yukon River chum and chinook salmon stocks also show promise, as an additional discriminating character (Cronin et al. In preparation). Analysis of nuclear DNA may also provide additional characters, and already appears useful in Fraser River chinook salmon stock discrimination (Terry Beacham personal communication).

While there are limitations in the precision of the stock composition estimates, the strengths are the general agreement of the results with the known run-timing of Yukon River chum and chinook salmon stocks, and the close agreement between chinook salmon stock composition estimates derived from scale pattern analysis and the estimates using GSI. In addition, the stability of the genetic characters over time means the baseline does not need to be resampled every year, and timely estimates of stock contributions to the fishery are possible.

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LITERATURE CITED

Aebersold, P. B., G. A. Winans, D. J. Teel, G. B. Milner, and F. M. Utter. 1987. Manual for starch gel electrophoresis: a method for the detection of genetic variation. NOAA Technical Report NMFS 61. Seattle, Washington.

Allendorf, F. W., and S. R. Phelps. 1981. Use of allelic frequencies to describe population structure. Canadian Journal of Fisheries and Aquatic Sciences 38:1507-1514.

Allendorf, F. W., and G. H. Thorgaard. 1984. Tetraploidy and the evolution of salmonid fishes. Pages 1-53 *in* B. Turner (ed.). Evolutionary Genetics of Fishes. Plenum Press, New York.

Barton, L. H. 1984. A catalog of Yukon River salmon spawning escapement surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 121, Juneau.

Beacham, T. D., R. E. Withler, and A. P. Gould. 1985. Biochemical genetic stock identification of chum salmon (*Oncorhynchus keta*) in southern British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 42:437-448.

Beacham, T. D., and C. B. Murray. 1987. Adaptive variation in body size, age, morphology, egg size, and developmental biology of chum salmon (*Oncorhynchus keta*) in British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 44:244-261.

Beacham, T. D., C. B. Murray, and R. E. Withler. 1988. Age, morphology, developmental biology, and biochemical genetic variation of Yukon River fall chum salmon (*Oncorhynchus keta*), and comparisons with British Columbia populations. Fishery Bulletin 86(4):663-674.

Beacham, T. D., C. B. Murray, and R. E. Withler. 1989. Age, morphology, and biochemical genetic variation of Yukon River chinook salmon. Transactions of the American Fisheries Society 118: 46-63.

Bergstrom, D. J., and seven co-authors. 1991. Annual management report, Yukon Area, 1989. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A91-14. Anchorage.

Buklis, L. S. 1981. Yukon and Tanana River fall chum tagging studies, 1976-1980. Alaska Department of Fish and Game Information Leaflet 194, Juneau, Alaska.

Cronin, M. A., R. L. Wilmot, W. Spearman, J. Patton, and J. Bickham. In preparation. Mitochondrial DNA variation in chinook and chum salmon detected by restriction enzyme analysis of PCR products.

Dempster, A. P., N. M. Laird, and D. B. Rubin. 1977. Maximum likelihood estimation from incomplete data via the EM algorithm. Journal of the Royal Statistical Society B: Methodology 39:1-38.

Efron, B. 1982. The jackknife, the bootstrap, and other resampling plans. National Science Foundation Conference Board of the Mathematical Sciences Monograph 38. SIAM, Philadelphia, 92 pp.

Fournier, D. A., T. D. Beacham, B. E. Riddell, and C. A. Busack. 1984. Estimating stock composition in mixed stock fisheries using morphometric, meristic, and electrophoretic characteristics. Canadian Journal of Fisheries and Aquatic Sciences 41:400-408.

Gall, G. A. E., B. Bentley, C. Panattoni, E. Childs, C. Qi, S. Fox, M. Mangel, J. Brodziak, and R. Gomulkiewicz. 1989. Chinook mixed fishery project 1986-1989. Report of University of California, Davis, California.

Gilbert, C. H. 1922. The salmon of the Yukon River. U.S. Bureau of Fisheries Bulletin 38:317-332.

Grant, W. S., G. B. Milner, P. Krasnowski, and F. M. Utter. 1980. Use of biochemical genetic variants for identification of sockeye salmon (*Oncorhynchus nerka*) stocks in Cook Inlet, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 37:1236-1247.

IUBNC (International Union of Biochemistry, Nomenclature Committee). 1984. Enzyme nomenclature. Academic Press, Orlando, Florida.

JTC (Joint United States/Canada Yukon River Technical Committee). 1990. Yukon River salmon season review for 1990 and technical report. Anchorage, Alaska.

Masuda, M., S. Nelson, and J. Pella. 1991. The computer programs for computing conditional maximum likelihood estimates of stock composition from discrete characters. USA-DOC-NOAA-NMFS, Auke Bay Laboratory, U.S. Canada Salmon Program. Auke Bay, Alaska.

McBride, D. N., and S. L. Marshall. 1983. Feasibility of scale pattern analysis to identify the origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the lower Yukon River commercial gillnet fishery, 1980-1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 208, Juneau.

Merritt, M. F. 1988. Origins of chinook salmon in the Yukon River fisheries, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 88-14, Juneau.

Merritt, M. F., J. A. Wilcock, and L. K. Brannian. 1988. Origins of chinook salmon in the Yukon River fisheries, 1986. Alaska Department of Fish and Game Technical Data Report No. 223, Juneau, Alaska.

Millar, R. B. 1987. Maximum likelihood estimation of mixed fishery composition. Canadian Journal of Fisheries and Aquatic Sciences 44:583-590.

Miller, M., P. Pattillo, G. Milner, and D. Teel. 1983. Analysis of chinook stock composition in the May, 1982 troll fishery off the Washington coast: on application of the genetic stock identification method. Washington Department of Fisheries Technical Report 74, Olympia, Washington.

Milligan, P. A., W. O. Rublec, D. D. Cornett, and R. A. C. Johnston. 1986. The distribution and abundance of chum salmon (*Oncorhynchus keta*) in the upper Yukon River basin as determined by a radio-tagging and spaghetti tagging program: 1982-1983. Canadian Technical Report Fisheries and Aquatic Sciences 1351, Ottawa, Canada.

Milner, G. B., D. J. Teel, F. M. Utter, and C. L. Burley. 1981. Columbia River stock identification study: validation of genetic method. Annual Report of Research (Fiscal Year 1980), NOAA, Northwest and Alaska Fisheries Center, Seattle, Washington.

Murray, C. B., M. L. Rosenau. 1989. Rearing of juvenile chinook salmon in nonnatal tributaries of the lower Fraser River, British Columbia. Transactions of the American Fisheries Society 118:284-289.

Nei, M. 1972. Genetic distance between populations. American Naturalist 196:283-292.

Okazaki, T. 1981. Geographical distribution of allelic variations of enzymes in chum salmon, *Oncorhynchus keta*, populations of North America. Bulletin of the Japanese Society of Scientific Fisheries 47:507-514.

Pella, J. J. 1986. The method of fitting expectations applied to computation of conditional maximum likelihood estimates of stock composition from genetic marks. U.S. DOC/NOAA/NMFS/NWAFC Auke Bay Laboratory Manuscript Report File No. 171. Auke Bay, Alaska.

Pella, J. J., and G. B. Milner. 1987. Use of genetic marks in stock compositions analysis. Pages 247-276 *in* N. Ryman and F. M. Utter, editors. Population genetics and fishery management. University of Washington Press, Seattle, Washington.

Scheiderhan, D. J., and J. A. Wilcock. 1992. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report, Juneau.

Shaklee, J. B., J. R. Phelps, and J. Salini. 1990a. Analysis of fish stock structure and mixed-stock fisheries by the electrophoretic characterization of allelic isozymes. Pages 173-196 *in* D. H. Whitmore (ed.). Electrophoretic and isoelectric focusing techniques in fisheries management. CRC Press, Boston.

Shaklee, J. B., F. W. Allendorf, D. C. Morizot, and G. S. Whitt. 1990b. Gene nomenclature for protein-coding loci in fish. Transactions of the American Fisheries Society 119:2-15.

Shaklee, J. B. 1991. Simulation and other analysis of the 1991 Columbia River spring chinook GSI baseline. Washington Department of Fisheries Technical Report No. 115. Olympia, Washington.

Sneath, P. H. A., and R. R. Sokal. 1973. Numerical Taxonomy. W. H. Freeman, San Francisco, 573 pp.

Sokal, R. R., and R. J. Rohlf. 1981. Biometry, 2nd edition. Freeman, San Francisco, California.

Swofford, D. L., and R. B. Selander. 1989. BIOSYS-1. A computer program for the analysis of allelic variation in population genetics and biochemical systematics. Illinois Natural History Survey. Champaign, Illinois.

Waples, R. S., and P. E. Smouse. 1990. Gametic disequilibrium analysis as a means of identifying mixtures of salmon populations. American Fisheries Society Symposium 7:439-458.

Wilcock, J. A., and D. N. McBride. 1983. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 226, Juneau.

Wilcock, J. A. 1984. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 243, Juneau.

Wilcock, J. A. 1985. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 157, Juneau.

Wilcock, J. A. 1986. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 178, Juneau.

Wilcock, J. A. 1987. Feasibility of using scale pattern analysis to identify the origins of chum salmon in Yukon River fisheries, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 87-02. Juneau, Alaska.

Wilcock, J. A. 1990. Origins of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) in the Yukon River fisheries, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 90-02, Juneau.

Wishard, L. 1981. Stock identification of Pacific salmon in western Washington using biochemical genetics. Final Report. Washington Department of Fisheries. Contract Nos. 1176 and 1276. Olympia, Washington.

Wood, C. C., S. McKinnel, T. J. Mulligan, and D. A. Fournier. 1987. Stock identification with the maximum-likelihood mixture model: sensitivity analysis and application to complex problems. Canadian Journal of Fisheries and Aquatic Sciences 44:866-881.

Appendix I. Distributions of the sample catch (N) for chum salmon from Emmonak, Alaska, by year, month, GSI period, and commercial opening. GSI period reflects the pattern of sample pooling that was used in data analyses.

Year	N	Month	N	GSI Period	N	Commercial Opening	N
1987	1295	JUN	375	1	160	1	160
				2	140	2	140
				3	150	3	150
		JUL	475	4	153	4	153
				5	87	5	87
				6	160	6	160
		AUG	445	7	126	8	126
				8	170	9	170
				9	149	10	149
	TOTALS		1295		1295		1295
1988	2016	JUN	664	1	224	1	92
				2	217	2	67
						3	75
						4	75
				3	223	5	73
						6	75
						7	75
		JUL	614	4	224	8	75
						9	75
						10	74
				5	166	11	61
						12	74
				6	163		
		AUG	738	7	140		
				8	239	13	179
				9	420	15	128
						16	171
						17	121
	TOTALS		2016		2016		1490

Year	N	Month	N	GSI Period	N	Commercial Opening	N
1989	1683	JUN	620	1	225	1	176
				2	235	2	235
				3	160	3	160
		JUL	566	4	158	4	158
				5	238	5	238
				6	170	6	170
		AUG	497	7	115	7	115
				8	155	8	155
				9	227	9	227
	TOTALS		1683		1683		1634
1990	1595	JUN	606	1	150		
				2	230	1	150
						2	80
				3	226	3	70
						4	77
		JUL	529	4	185	5	38
				5	205		
				6	139	6	30
						7	40
						8	55
		AUG	460	7	192	9	80
						10	40
				8	130		
				9	138	11	80
	TOTALS		1595		1595		740

Appendix II. Distributions of the sample catch (N) for chinook salmon from Emmonak, Alaska, by year, month, GSI period, and commercial opening. GSI period reflects the pattern of sample pooling that was used in data analyses.

Year	N	Month	N	GSI Period	N	Commercial Opening	N
1987	768	JUN	561	1	186		
				2	225	1	150
		JUL	207	3	225	2	120
						3	180
				4	132	4	122
						5	10
		Totals	768		768		582
1988	891	JUN	603	1	215	1	118
				2	140	2	66
						4	74
				3	232	5	76
						6	75
						7	61
		JUL	288	4	205	8	89
						9	54
						10	32
				5	99	11	52
						12	42
		Totals	891		891		739
1989	995	JUN	814	1	245	1	193
				2	409	2	409
				3	160	3	160
		JUL	181	4	181	4	155
						5	26
		Totals	995		995		943
1990	939	JUN	730	1	250	1	156
				2	250	2	100
						3	150
				3	230	4	150
		JUL	209	4	209	5	150
		Totals	939		939		706

Appendix III. Chum salmon sample collection summary for the mixed-stock fishery sample-catch from the Yukon River at Emmonak. Big Eddy and Middle Mouth catches were from test fisheries operated by Alaska Department of Fish and Game.

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
1987	1	1	16-Jun	Commercial	Commercial	8.5	75
	1	1	19-Jun	Commercial	Commercial	8.5	85
	2	2	23-Jun	Commercial	Commercial	8.5	65
	2	2	26-Jun	Commercial	Commercial	8.5	75
	3	3	30-Jun	Commercial	Commercial	5.5	75
	3	3	03-Jul	Commercial	Commercial	5.5	75
	4	4	06-Jul	Big Eddy	Set Net	5.5	32
	4	4	07-Jul	Big Eddy	Set Net	5.5	38
	4	4	08-Jul	Big Eddy	Set Net	5.5	31
	4	4	09-Jul	Big Eddy	Set Net	5.5	10
	4	4	10-Jul	Big Eddy	Set Net	5.5	25
	4	4	11-Jul	Big Eddy	Set Net	5.5	17
	5	5	13-Jul	Big Eddy	Set Net	5.5	25
	5	5	14-Jul	Big Eddy	Set Net	5.5	16
	5	5	15-Jul	Big Eddy	Set Net	5.5	13
	5	5	16-Jul	Big Eddy	Set Net	6.0	3
	5	5	17-Jul	Big Eddy	Set Net	6.0	10
	5	5	18-Jul	Big Eddy	Set Net	6.0	5
	5	5	19-Jul	Big Eddy	Set Net	6.0	11
	5	.	20-Jul	Big Eddy	Set Net	6.0	4
	6	6	21-Jul	Big Eddy	Set Net	6.0	8
	6	6	22-Jul	Big Eddy	Set Net	6.0	3
	6	6	22-Jul	Middle Mouth	Set Net	6.0	20
	6	6	23-Jul	Big Eddy	Set Net	6.0	20
	6	6	23-Jul	Middle Mouth	Set Net	6.0	30
	6	6	24-Jul	Big Eddy	Set Net	6.0	21
	6	6	24-Jul	Middle Mouth	Set Net	6.0	30
	6	6	25-Jul	Big Eddy	Set Net	6.0	9

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	6	6	26-Jul	Big Eddy	Set Net	6.0	9
	6	6	26-Jul	Middle Mouth	Set Net	6.0	10
	7	7	06-Aug	Middle Mouth	Set Net	6.0	1
	7	7	07-Aug	Big Eddy	Set Net	6.0	3
	7	7	08-Aug	Big Eddy	Set Net	6.0	23
	7	7	08-Aug	Middle Mouth	Set Net	6.0	73
	7	7	09-Aug	Big Eddy	Set Net	6.0	23
	7	7	10-Aug	Big Eddy	Set Net	6.0	3
	8	8	12-Aug	Big Eddy	Set Net	6.0	7
	8	8	12-Aug	Middle Mouth	Set Net	6.0	6
	8	8	13-Aug	Big Eddy	Set Net	6.0	46
	8	8	14-Aug	Big Eddy	Set Net	6.0	9
	8	8	15-Aug	Big Eddy	Set Net	6.0	18
	8	8	16-Aug	Big Eddy	Set Net	6.0	57
	8	8	16-Aug	Middle Mouth	Set Net	6.0	8
	8	8	17-Aug	Big Eddy	Set Net	6.0	19
	9	9	20-Aug	Big Eddy	Set Net	6.0	12
	9	9	22-Aug	Big Eddy	Set Net	6.0	19
	9	9	23-Aug	Big Eddy	Set Net	6.0	77
	9	9	24-Aug	Big Eddy	Set Net	6.0	12
	9	9	25-Aug	Big Eddy	Set Net	6.0	1
	9	9	26-Aug	Big Eddy	Set Net	6.0	21
	9	9	26-Aug	Middle Mouth	Set Net	6.0	7
1988	1	.	05-Jun	Big Eddy	Set Net	5.5	25
	1	.	06-Jun	Big Eddy	Set Net	5.5	19
	1	.	07-Jun	Test Fishery	Drift Net	.	13
	1	.	07-Jun	Big Eddy	Set Net	5.5	47
	1	.	08-Jun	Big Eddy	Set Net	5.5	28
	1	1	09-Jun	Big Eddy	Set Net	5.5	17
	1	1	10-Jun	Commercial	Commercial	6.0	75
	2	2	14-Jun	Commercial	Commercial	8.5	67

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	2	3	15-Jun	Commercial	Commercial	6.0	75
	2	4	17-Jun	Commercial	Commercial	8.5	75
	3	5	21-Jun	Commercial	Commercial	8.5	73
	3	6	24-Jun	Commercial	Commercial	6.0	75
	3	7	28-Jun	Commercial	Commercial	6.0	75
	4	8	01-Jul	Commercial	Commercial	6.0	75
	4	9	05-Jul	Commercial	Commercial	6.0	75
	4	10	08-Jul	Commercial	Commercial	6.0	74
	5	.	10-Jul	Test Fishery	Set Net	.	4
	5	.	10-Jul	Big Eddy	Set Net	5.5	10
	5	11	11-Jul	Big Eddy	Set Net	5.5	10
	5	11	12-Jul	Commercial	Commercial	6.0	51
	5	.	13-Jul	Big Eddy	Set Net	5.5	17
	5	12	14-Jul	Big Eddy	Set Net	5.5	12
	5	12	15-Jul	Commercial	Commercial	6.0	62
	6	.	17-Jul	Big Eddy	Set Net	6.0	23
	6	.	18-Jul	Big Eddy	Set Net	6.0	16
	6	.	19-Jul	Big Eddy	Set Net	6.0	13
	6	.	20-Jul	Big Eddy	Set Net	6.0	13
	6	.	21-Jul	Big Eddy	Set Net	6.0	8
	6	.	22-Jul	Big Eddy	Set Net	6.0	8
	6	.	23-Jul	Big Eddy	Set Net	6.0	9
	6	.	24-Jul	Big Eddy	Set Net	6.0	13
	6	.	25-Jul	Big Eddy	Set Net	6.0	30
	6	.	26-Jul	Big Eddy	Set Net	6.0	30
	7	.	27-Jul	Big Eddy	Set Net	6.0	23
	7	.	28-Jul	Big Eddy	Set Net	6.0	6
	7	.	29-Jul	Big Eddy	Set Net	6.0	1
	7	.	30-Jul	Big Eddy	Set Net	6.0	9
	7	.	31-Jul	Big Eddy	Set Net	6.0	22
	7	.	01-Aug	Big Eddy	Set Net	6.0	12

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	7	.	02-Aug	Big Eddy	Set Net	6.0	2
	7	.	03-Aug	Big Eddy	.	6.0	1
	7	.	04-Aug	Middle Mouth	Set Net	6.0	19
	7	.	05-Aug	Big Eddy	.	6.0	25
	7	.	05-Aug	Middle Mouth	Set Net	6.0	8
	7	.	06-Aug	Big Eddy	.	6.0	12
	8	13	08-Aug	Big Eddy	Set Net	6.0	30
	8	13	09-Aug	Commercial	Commercial	6.0	149
	8	.	10-Aug	Big Eddy	Set Net	6.0	3
	8	.	11-Aug	Big Eddy	Set Net	6.0	15
	8	.	13-Aug	Big Eddy	Set Net	6.0	13
	8	.	15-Aug	Test Fishery	Set Net	.	12
	8	.	15-Aug	Big Eddy	Set Net	6.0	13
	8	.	16-Aug	Test Fishery	Set Net	.	4
	9	15	23-Aug	Commercial	Commercial	6.0	128
	9	16	26-Aug	Commercial	Commercial	6.0	171
	9	17	30-Aug	Commercial	Commercial	6.0	121
1989	1	.	12-Jun	Big Eddy	Set Net	5.5	49
	1	1	13-Jun	Big Eddy	Set Net	5.5	26
	1	1	14-Jun	Commercial	Commercial	5.5	75
	1	1	16-Jun	Commercial	Commercial	8.5	75
	2	2	20-Jun	Commercial	Commercial	8.5	80
	2	2	23-Jun	Commercial	Commercial	8.5	75
	2	2	25-Jun	Commercial	Commercial	5.5	80
	3	3	27-Jun	Commercial	Commercial	5.5	80
	3	3	30-Jun	Commercial	Commercial	5.5	80
	4	4	04-Jul	Commercial	Commercial	5.5	80
	4	4	07-Jul	Commercial	Commercial	5.5	78
	5	5	11-Jul	Commercial	Commercial	5.5	80
	5	5	14-Jul	Commercial	Commercial	5.5	79

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	5	5	16-Jul	Big Eddy	Set Net	6.0	79
	6	6	19-Jul	Middle Mouth	Set Net	6.0	40
	6	6	20-Jul	Middle Mouth	Set Net	6.0	40
	6	6	23-Jul	Big Eddy	Set Net	6.0	11
	6	6	24-Jul	Big Eddy	Set Net	6.0	2
	6	6	28-Jul	Big Eddy	.	6.0	37
	6	6	28-Jul	Commercial	Commercial	6.0	40
	7	7	01-Aug	Commercial	Commercial	6.0	35
	7	7	04-Aug	Commercial	Commercial	6.0	80
	8	8	08-Aug	Commercial	Commercial	6.0	75
	8	8	11-Aug	Commercial	Commercial	6.0	80
	9	9	15-Aug	Commercial	Commercial	6.0	79
	9	9	19-Aug	Middle Mouth	Set Net	6.0	75
	9	9	22-Aug	Commercial	Commercial	6.0	73
1990	1	.	06-Jun	Big Eddy	Set Net	5.5	8
	1	.	07-Jun	Big Eddy	Set Net	5.5	13
	1	.	08-Jun	Big Eddy	Set Net	5.5	11
	1	.	09-Jun	Big Eddy	Set Net	5.5	17
	1	.	10-Jun	Big Eddy	Set Net	5.5	30
	1	.	11-Jun	Big Eddy	Set Net	5.5	21
	1	.	12-Jun	Big Eddy	Set Net	5.5	23
	1	.	13-Jun	Big Eddy	Set Net	5.5	27
	2	1	15-Jun	Commercial	Commercial	8.5	150
	2	2	19-Jun	Commercial	Commercial	5.5	80
	3	3	22-Jun	Commercial	Commercial	8.5	70
	3	.	25-Jun	Big Eddy	Set Net	5.5	20
	3	.	26-Jun	Big Eddy	Set Net	5.5	47
	3	.	27-Jun	Big Eddy	Set Net	5.5	12
	3	4	29-Jun	Commercial	Commercial	8.5	77
	4	5	03-Jul	Commercial	Commercial	8.5	38

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	4	.	06-Jul	Middle Mouth	Set Net	5.5	15
	4	.	08-Jul	Big Eddy	Set Net	5.5	27
	4	.	09-Jul	Big Eddy	Drift Net	5.5	20
	4	.	09-Jul	Middle Mouth	Set Net	5.5	22
	4	.	10-Jul	Big Eddy	Set Net	5.5	43
	4	.	11-Jul	Big Eddy	Set Net	5.5	20
	5	.	14-Jul	Big Eddy	Set Net	5.5	20
	5	.	15-Jul	Big Eddy	Set Net	5.5	30
	5	.	16-Jul	Big Eddy	Set Net	6.0	15
	5	.	16-Jul	Middle Mouth	Set Net	6.0	20
	5	.	17-Jul	Big Eddy	Set Net	6.0	30
	5	.	19-Jul	Big Eddy	Set Net	6.0	30
	5	.	20-Jul	Big Eddy	Set Net	6.0	30
	5	.	20-Jul	Middle Mouth	Set Net	6.0	30
	6	6	24-Jul	Commercial	Commercial	6.0	30
	6	7	27-Jul	Commercial	Commercial	6.0	40
	6	.	29-Jul	Middle Mouth	Set Net	6.0	14
	6	8	31-Jul	Commercial	Commercial	6.0	55
	7	9	03-Aug	Commercial	Commercial	6.0	80
	7	10	07-Aug	Commercial	Commercial	6.0	40
	7	.	08-Aug	Commercial	Commercial	6.0	72
	8	.	11-Aug	Middle Mouth	Set Net	6.0	15
	8	.	12-Aug	Middle Mouth	Set Net	6.0	1
	8	.	13-Aug	Big Eddy	Set Net	6.0	44
	8	.	14-Aug	Big Eddy	Set Net	6.0	20
	8	.	15-Aug	Big Eddy	Set Net	6.0	20
	8	.	18-Aug	Big Eddy	Set Net	6.0	30
	9	11	20-Aug	Commercial	Commercial	6.0	80
	9	.	21-Aug	Big Eddy	Set Net	6.0	8
	9	.	23-Aug	Big Eddy	Set Net	6.0	10
	9	.	23-Aug	Middle Mouth	Set Net	6.0	40

Appendix IV. Chinook salmon collection summary for the mixed-stock fishery sample-catch from the Yukon River at Emmonak. Big Eddy and Middle Mouth catches were from test fisheries operated by Alaska Department of Fish and Game.

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
1987	1	.	05-Jun	Big Eddy	Drift	5.5	2
	1	.	05-Jun	Subsistence	Set	8.5	5
	1	.	06-Jun	Big Eddy	Set	8.5	6
	1	.	06-Jun	Subsistence	Set	8.5	11
	1	.	07-Jun	Big Eddy	Set	8.5	14
	1	.	07-Jun	Subsistence	Set	8.5	40
	1	.	08-Jun	Big Eddy	Set	8.5	1
	1	.	08-Jun	Subsistence	Set	8.5	7
	1	.	09-Jun	Big Eddy	Set	8.5	9
	1	.	09-Jun	Subsistence	Set	8.5	36
	1	.	10-Jun	Big Eddy	Set	8.5	10
	1	.	10-Jun	Subsistence	Set	8.5	10
	1	.	11-Jun	Big Eddy	Set	8.5	3
	1	.	11-Jun	Subsistence	Set	8.5	17
	1	.	12-Jun	Big Eddy	Drift	8.5	10
	1	.	13-Jun	Big Eddy	Drift	8.5	5
	2	1	16-Jun	Commercial	Commercial	8.5	75
	2	1	19-Jun	Commercial	Commercial	8.5	75
	2	2	23-Jun	Commercial	Commercial	8.5	75
	3	2	26-Jun	Commercial	Commercial	8.5	45
	3	3	30-Jun	Commercial	Commercial	5.5	105
	3	3	03-Jul	Commercial	Commercial	5.5	75
	4	4	06-Jul	Big Eddy	Set	8.5	48
	4	4	07-Jul	Big Eddy	Set	8.5	18
	4	4	08-Jul	Big Eddy	Set	8.5	30
	4	4	09-Jul	Big Eddy	Set	8.5	8
	4	4	10-Jul	Big Eddy	Set	8.5	8
	4	4	11-Jul	Big Eddy	Set	8.5	10
	4	5	13-Jul	Big Eddy	Set	8.5	4
	4	5	14-Jul	Big Eddy	Set	8.5	1
	4	5	15-Jul	Big Eddy	Set	8.5	5
1988	1	.	05-Jun	.	.	.	4
	1	.	05-Jun	Big Eddy	Set	5.5	6

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	1	.	06-Jun	Big Eddy	Set	8.5	8
	1	.	07-Jun	Big Eddy	Set	8.5	40
	1	.	08-Jun	Big Eddy	Set	8.5	39
	1	1	09-Jun	Big Eddy	Set	8.5	43
	1	1	10-Jun	Commercial	Commercial	6.0	75
	2	2	14-Jun	.	.	.	1
	2	2	14-Jun	Big Eddy	Set	8.5	10
	2	2	14-Jun	Commercial	Commercial	8.5	55
	2	4	17-Jun	Commercial	Commercial	8.5	74
	3	5	21-Jun	Commercial	Commercial	8.5	76
	3	6	24-Jun	Commercial	Commercial	6.0	75
	3	7	28-Jun	Commercial	Commercial	6.0	61
	3	.	29-Jun	Big Eddy	Set	8.5	20
	4	8	30-Jun	Big Eddy	Set	8.5	16
	4	8	01-Jul	Commercial	Commercial	6.0	73
	4	.	03-Jul	Big Eddy	Set	8.5	24
	4	9	04-Jul	Big Eddy	Set	8.5	3
	4	9	05-Jul	Commercial	Commercial	6.0	51
	4	.	06-Jul	Big Eddy	Set	8.5	4
	4	.	07-Jul	Big Eddy	Set	8.5	2
	4	10	08-Jul	Commercial	Commercial	6.0	32
	5	11	11-Jul	Big Eddy	Set	8.5	2
	5	11	12-Jul	.	.	.	10
	5	11	12-Jul	Commercial	Commercial	6.0	40
	5	.	13-Jul	Big Eddy	Set	8.5	5
	5	12	14-Jul	Big Eddy	Set	8.5	6
	5	12	15-Jul	Commercial	Commercial	6.0	36
1989	1	.	10-Jun	Big Eddy	Set	8.5	26
	1	.	11-Jun	Big Eddy	Set	8.5	14
	1	.	12-Jun	Big Eddy	Set	8.5	12
	1	1	13-Jun	Big Eddy	Set	8.5	12
	1	1	14-Jun	Commercial	Commercial	6.0	6
	1	1	16-Jun	Commercial	Commercial	8.5	175
	2	2	20-Jun	Commercial	Commercial	8.5	170
	2	2	23-Jun	Commercial	Commercial	8.5	149
	2	2	25-Jun	Commercial	Commercial	5.5	90

Year	GSI Period	Commercial Opening	Date	Location	Gear	Mesh (inches)	N
	3	3	27-Jun	Commercial	Commercial	5.5	80
	3	3	30-Jun	Commercial	Commercial	5.5	80
	4	4	04-Jul	Commercial	Commercial	5.5	55
	4	4	05-Jul	Big Eddy	Set	8.5	20
	4	4	07-Jul	Commercial	Commercial	5.5	80
	4	5	11-Jul	Commercial	Commercial	5.5	10
	4	5	12-Jul	Middle Mouth	Set	5.5	6
	4	5	14-Jul	Commercial	Commercial	5.5	10
1990	1	.	07-Jun	Big Eddy	Set	8.5	6
	1	.	08-Jun	Big Eddy	Set	8.5	12
	1	.	09-Jun	Big Eddy	Set	8.5	21
	1	.	10-Jun	Big Eddy	Set	8.5	8
	1	.	11-Jun	Big Eddy	Set	8.5	17
	1	.	12-Jun	Big Eddy	Set	8.5	5
	1	.	13-Jun	Big Eddy	Set	8.5	25
	1	1	14-Jun	Big Eddy	Set	8.5	6
	1	1	15-Jun	Commercial	Commercial	8.5	150
	2	2	19-Jun	Commercial	Commercial	5.5	100
	2	3	22-Jun	Commercial	Commercial	8.5	150
	3	.	25-Jun	Big Eddy	Set	5.5	2
	3	.	26-Jun	Big Eddy	Set	8.5	40
	3	.	27-Jun	Big Eddy	Set	8.5	38
	3	4	29-Jun	Commercial	Commercial	8.5	150
	4	5	02-Jul	.	.	.	6
	4	5	02-Jul	Commercial	Commercial	8.5	144
	4	.	08-Jul	Big Eddy	Set	8.5	9
	4	.	09-Jul	Big Eddy	Set	8.5	6
	4	.	09-Jul	Middle Mouth	Set	8.5	4
	4	.	10-Jul	Big Eddy	Set	8.5	8
	4	.	11-Jul	Big Eddy	Set	8.5	4
	4	.	12-Jul	Big Eddy	Set	8.5	3
	4	.	13-Jul	Big Eddy	Set	8.5	13
	4	.	14-Jul	Big Eddy	Set	8.5	10
	4	.	15-Jul	Big Eddy	Set	8.5	2

Appendix V. Enzymes assayed for chum salmon loci showing buffer and tissue combinations used (H=heart; M=muscle; L=liver; E=eye). Nomenclature generally follows recommendations of IUBNC (1984) and Shaklee et al. (1990a). See Appendix XXV for buffer definitions.

Enzyme Name	Enzyme Number	Locus	Buffer	Tissue
Polymorphic Loci Used In Analyses				
Aspartate aminotransferase	2.6.1.1	*mAAT-1*	CAM 6.05	H
			CAME 7.0	H
			CAME 7.0	M
		sAAT-1,2	CAME 7.0	H
			CAME 7.0	M
			KG	M
Alanine aminotransferase	2.6.1.2	*ALAT*	EBT	H
			EBT	M
			CAME 7.0	M
Esterase-D	3.1.*.*	*ESTD*	KG	H
			EBT	M
N-Acetyl-beta-glucosaminidase	3.2.1.30	*bGLUA*	CAME7.0	L
Glycerol-3-phosphate dehydrogenase (NAD+)	1.1.1.8	*G3PDH-2*	CAM 6.05	H
			KG	H
			CAME 7.0	M
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*mIDHP-1*	CAME 7.0	H
			CAME 7.0	M
		sIDHP-2	CAME 7.0	L
Lactate dehydrogenase	1.1.1.27	*LDH-A1*	KG	M
Malate dehydrogenase	1.1.1.37	*sMDH-A1*	CAM 6.3	E
			CAM 6.05	H
			CAM 6.05	L
		sMDH-A2	CAM 6.3	E
			CAM 6.05	H
			CAM 6.05	L
		sMDH-B1,2	CAM 6.3	E
			KG	H
			CAM 6.05	H

Enzyme Name	Enzyme Number	Locus	Buffer	Tissue
			KG	M
Malate dehydrogenase (oxaloacetate-decarboxylating)(NADP+)	1.1.1.40	*mMEP-2*	CAME7.0	H
			CAME7.0	M
			KG	M
Mannose-6-phosphate isomerase	5.3.1.8	*MPI*	EBT	E
			KG	E
			EBT	H
			CAME 7.0	H
			CAME 6.8	L
Tripeptide aminopeptidase	3.4.*.*	*PEPB-1*	EBT	H
			CAM 6.05	H
			KG	H
			CAM 6.05	L
			EBT	M
		PEPB-2	EBT	H
			KG	H
			EBT	M
Leucyl-tyrocine peptidase	3.4.*.*	*PEP-LT*	CAM 6.8	L
			CAM 6.05	L
			KG	M
			CAME 7.0	M
Phosphogluconate dehydrogenase (decarboxylating)	1.1.1.44	*PGDH*	CAME 7.0	H
			CAME 7.0	L
			CAME 7.0	M
Triose-phosphate isomerase	5.3.1.1	*TPI-1*	KG	E
			EBT	H
			KG	M
Polymorphic Loci Not Used In Analyses				
Aspartate aminotransferase	2.6.1.1	*sAAT-3*	KG	E
Aconitate hydratase	4.2.1.3	*mAH-3*	CAME 7.0	H
Creatine kinase	2.7.3.2	*CK-A1*	EBT	M
		CK-C2	EBT	E

Enzyme Name	Enzyme Number	Locus	Buffer	Tissue
Formaldehyde dehydrogenase	1.2.1.1	*FGDH*	CAME 7.0	L
(glutathione)			CAM 6.8	L
beta-Galactosidase	3.2.1.23	*bGALA*	CAM 6.05	L
Guanine deaminase	3.5.4.3	*GDA*	CAM 6.8	L
Glucose-6-phosphate isomerase	5.3.1.9	*GPI-B1,2*	EBT	H
			EBT	M
Dipeptidase	3.4.*.*	*PEPA*	CAM 6.3	E
			CAM 6.05	H
			CAM 6.8	L
			CAM 6.05	L
Phosphoglucomutase	5.4.2.2	*PGM-1*	EBT	H
			CAM 6.8	L
		PGM-2	EBT	H
			CAM 6.8	L
			KG	M
		PGM-3,4	CAM 6.8	L
Triose-phosphate isomerase	5.3.1.1	*TPI-3*	KG	E
			EBT	H
			KG	M
		TPI-4	KG	E
			EBT	H
			KG	M
Monomorphic Loci Not Used In Analyses				
Aspartate aminotransferase	2.6.1.1	*sAAT-4*	CAM 6.05	L
Acid phosphatase	3.1.3.2	*ACP*	CAME 7.0	L
Adenosine deaminase	3.5.4.4	*ADA-1*	CAM 6.3	E
			CAME 7.0	H
			CAM 6.05	H
			CAM 6.05	L
		ADA-2	CAM 6.3	E
			CAM 6.05	H
			CAME 7.0	H

Enzyme Name	Enzyme Number	Locus	Buffer	Tissue
			CAM 6.05	L
Aconitate hydratase	4.2.1.3	*mAH-1,2*	CAME 7.0	H
		mAH-4	CAME 7.0	H
		sAH	CAM 6.8	L
Creatine kinase	2.7.3.2	*CK-A2*	EBT	M
		CK-B	EBT	E
		CK-C1	EBT	E
Diaphorase	1.6.*.*	*DIA*	KG	H
Fumarate hydratase	4.2.1.2	*FH*	CAME 7.0	L
Glyceraldehyde-3-phosphate	1.2.1.12	*GAPDH-4*	CAM 6.3	E
dehydrogenase		*GAPDH-5*	CAM 6.3	E
Glycerol-3-phosphate dehydrogenase	1.1.1.8	*G3PDH-1*	CAM 6.05	H
			KG	H
			CAME 7.0	M
		G3PDH-3	CAM 6.05	H
			KG	H
			CAME 7.0	M
		G3PDH-4	CAM 6.05	H
			KG	H
			CAME 7.0	M
Glucose-6-phosphate isomerase	5.3.1.9	*GPI-A*	EBT	E
			CAM 6.3	E
			EBT	H
			EBT	M
Glutathione reductase (NAD(P)H)	1.6.4.2	*GR*	KG	E
			KG	H
Hydroxyacylglutathione hydrolase	3.1.2.6	*HAGH*	KG	M
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*mIDHP-2*	CAME 7.0	H
			CAME 7.0	M
		sIDHP-1	CAME 7.0	L
Lactate dehydrogenase	1.1.1.27	*LDH-A2*	KG	M
		LDH-B1	KG	E

Enzyme Name	Enzyme Number	Locus	Buffer	Tissue
			EBT	H
		LDH-B2	KG	E
			EBT	H
			CAME 7.0	L
		LDH-C	KG	E
alpha-Mannosidase	3.2.1.24	*aMAN*	CAM 6.05	L
Malate dehydrogenase	1.1.1.37	*mMDH-1*	CAM 6.3	E
			CAM 6.05	H
			CAM 6.05	L
Malate dehydrogenase(oxaloacetate	1.1.1.40	*sMEP-1*	CAME7.0	H
decarboxylating(NADP+)			CAME7.0	M
			KG	M
alpha-Naphthyl propionate esterase	3.1.*.*	*EST*	CAM 6.05	L
Proline dipeptidase	3.4.13.9	*PEPD*	CAM 6.05	H
Phosphoglycerate kinase	2.7.2.3	*PGK-1*	CAM 6.05	H
			CAME 7.0	L
		PGK-2	CAM 6.05	H
			CAME 7.0	L
Purine-nucleoside phosphorylase	2.4.2.1	*PNP*	CAM 6.3	E
Superoxide dismutase	1.15.1.1	*sSOD*	KG	M
Triose-phosphate isomerase	5.3.1.1	*TPI-2*	KG	E
			EBT	H
			KG	M
Xanthine dehydrogenase	1.2.3.2	*XDH*	KG	E

Appendix VI. Enzymes assayed for chinook salmon loci showing buffer and tissue combinations used (H=heart; M=muscle; L=liver; E=eye). Nomenclature generally follows recommendations of IUBNC (1984) and Shaklee et al. (1990a). See Appendix XXV for buffer definitions.

Enzyme name	Enzyme number	Locus	Buffer	Tissue
Polymorphic Loci Used In Analyses				
Aspartate aminotransferase	2.6.1.1	*sAAT-3*	KG	E
			CAME 7.0	E
		sAAT-4	EBT	L
			TC-4	L
Adenosine deaminase	3.5.4.4	*ADA-1*	KG	H
			KG	M
Aconitate hydratase	4.2.1.3	*sAH*	CAME 7.0	E
			TC-4	L
			CAME 7.0	M
Alanine aminotransferase	2.6.1.2	*ALAT*	KG	H
			KG	M
Dipeptidase	3.4.*.*	*PEPA*	CAME 7.0	E
			CAME 7.0	H
			CAME 7.0	M
Glucose-6-phosphate isomerase	5.3.1.9	*GPI-B1*	KG	M
L-Iditol dehydrogenase	1.1.1.14	*IDDH-1*	TC-4	H
			KG	H
			EBT	L
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*sIDHP-3*	CAME 7.0	H
			TC-4	H
			CAME 7.0	M
		sIDHP-4	CAME 7.0	E
			TC-4	L
Lactate dehydrogenase	1.1.1.27	*LDH-4*	KG	E
			EBT	L
Malate dehydrogenase	1.1.1.40	*sMEP-1*	TC-4	H
(oxaloacetate-			TC-4	L

Enzyme name	Enzyme number	Locus	Buffer	Tissue
decarboxylating)(NADP+)			CAME 7.0	M
		sMEP-2	TC-4	H
			TC-4	L
			CAME 7.0	M
Malate dehydrogenase	1.1.1.37	*sMDH-B1,2*	CAME 7.0	H
			CAME 7.0	M
Mannose-6-phosphate isomerase	5.3.1.8	*MPI*	KG	H
			KG	M
Phosphoglucomutase	5.4.2.2	*PGM-1*	KG	E
			TC-4	H
			KG	M
Superoxide dismutase	1.15.1.1	*mSOD-1*	KG	H
			TC-4	H
			TC-4	L
			KG	M
		sSOD-1	KG	H
			TC-4	H
			TC-4	L
			KG	M
Tripeptide aminopeptidase	3.4.*.*	*PEPB-1*	CAME 7.0	E
			KG	E
			KG	H
			TC-4	H
			TC-4	L
			KG	M
Triose-phosphate isomerase	5.3.1.1	*TPI-1*	KG	H
			KG	M
		TPI-2	KG	H
			KG	M
		TPI-4	KG	H
			KG	M

Enzyme name	Enzyme number	Locus	Buffer	Tissue
Polymorphic Loci Not Used In Analyses				
Aspartate aminotransferase	2.6.1.1	*sAAT-1,2*	CAME 7.0	H
			CAME 7.0	M
Adenosine deaminase	3.5.4.4	*ADA-2*	KG	H
			KG	M
Creatine kinase	2.7.3.2	*CK-A2*	KG	M
Glucose-6-phosphate isomerase	5.3.1.9	*GPI-B2*	KG	M
		GPI	KG	M
L-Iditol dehydrogenase	1.1.1.14	*IDDH-2*	TC-4	H
			KG	H
			EBT	L
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*sIDHP-2*	CAME 7.0	E
			CAME 7.0	H
			TC-4	H
Lactate dehydrogenase	1.1.1.27	*LDH-B1*	KG	E
			KG	H
		LDH-C	KG	E
			KG	E
Malate dehydrogenase	1.1.1.37	*sMDH-A1,2*	CAME 7.0	H
			TC-4	L
			CAME 7.0	M
Leucyl-tyrocine peptidase	3.4.*.*	*PEP-LT*	TC-4	H
			KG	M
			CAME 7.0	M
Phosphoglucomutase	5.4.2.2	*PGM-2*	KG	E
			TC-4	H
			TC-4	L
			KG	M
			KG	M
Phosphoglucomutase	5.4.2.2	*PGM-3,4*	TC-4	H
			TC-4	L

Enzyme name	Enzyme number	Locus	Buffer	Tissue
Monomorphic Loci Not Used in Analysis				
Aspartate aminotransferase	2.6.1.1	*mAAT-1*	CAME 7.0	H
			CAME 7.0	H
			CAME 7.0	M
Acid phosphatase	3.1.3.2	*ACP*	CAME 7.0	H
			TC-4	L
Alcohol dehydrogenase	1.1.1.1	*ADH*	EBT	L
			TC-4	L
Aconitate hydratase	4.2.1.3	*mAH-3*	CAME 7.0	H
			CAME 7.0	M
		mAH-4	CAME 7.0	H
			CAME 7.0	M
Creatine kinase	2.7.3.2	*CK-A1*	KG	M
		CK-C1	KG	E
		CK-C2	KG	E
		CK-B	KG	E
alpha-Naphthyl propionate esterase	3.1.*.*	*EST*	TC-4	L
Esterase-D	3.1.*.*	*ESTD*	KG	E
			CAME 7.0	M
Fumarate hydratase	4.2.1.2	*FH*	CAME 7.0	H
Glycerol-3-phosphate	1.1.1.8	*G3PDH-1*	TC-4	H
dehydrogenase (NAD+)		*G3PDH-2*	TC-4	H
		G3PDH-3	TC-4	H
		G3PDH-4	TC-4	H
beta-Galactosidase	3.2.1.23	*b-GALA*	TC-4	L
Glucose-6-phosphate isomerase	5.3.1.9	*GPI-A*	KG	H
			KG	M
Glutathione reductase(NAD(P)H)	1.6.4.2	*GR*	TC-4	H
			KG	H
			EBT	L
Hydroxyacylglutathione hydrolase	3.1.2.6	*HAGH*	EBT	L

Enzyme name	Enzyme number	Locus	Buffer	Tissue
			KG	M
N-Acetyl-beta-glucosaminidase	3.2.1.30	*bGLUA*	TC-4	L
Isocitrate dehydrogenase (NADP+)	1.1.1.42	*sIDHP-1*	CAME 7.0	E
			TC-4	H
			CAME 7.0	H
			CAME 7.0	M
Lactate dehydrogenase	1.1.1.27	*LDH-A1*	KG	M
		LDH-A2	KG	M
alpha-Mannosidase	3.2.1.24	*aMAN*	EBT	L
Malate dehydrogenase	1.1.1.37	*mMDH-1*	CAME 7.0	H
			CAME 7.0	M
Phosphogluconate dehydrogenase	1.1.1.44	*PGDH*	CAME 7.0	E
(decarboxylating)			CAME 7.0	M
Proline dipeptidase	3.4.13.9	*PEPD-2*	TC-4	H
			TC-4	L
			CAME 7.0	M
Phosphoglycerate kinase	2.7.2.3	*PGK-1*	CAME 7.0	H
			CAME 7.0	M
		PGK-2	CAME 7.0	H
			CAME 7.0	M
Tripeptide aminopeptidase	3.4.*.*	*PEPB-2*	CAME 7.0	E
			KG	E
Triose-phosphate isomerase	5.3.1.1	*TPI-3*	KG	H
			KG	M

Appendix VII. Allelic frequencies at 19 polymorphic loci for chum salmon sampled from the Yukon River drainage during 1987-1990. The most common allele is designated as 100, and other alleles assigned numbers according to their mobility relative to the 100 allele. N is the sample size. Allele designatiors separated by a slash indicates that the data for those alleles were pooled. An asterisk indicates significant deviation from Hardy-Weinberg Equilibrium (* = $p < 0.05$, ** = $p < 0.01$, and *** = $p < 0.001$).

		sAAT-1			mAAT-1				ALAT			ESTD		
Stock	Year	N	100	120	N	-100	-120	-70	N	100	93	N	100	91
United States Summer Run														
Andreafsky	1987	150	0.923	0.077	37	0.946	0.000	0.054	149	0.866	0.134	150	0.547	0.453
Chulinak	1989	99	0.919	0.081	99	0.944	0.005	0.051	99	0.859	0.141	99	0.470	0.530
Anvik	1987	150	0.927	0.073	89	0.905	0.000	0.096	150	0.897	0.103	150	0.427	0.573
	1988	100	0.960	0.040	100	0.920	0.000	0.080	100	0.875	0.125	100	0.545	0.455
Rodo	1989	77	0.890	0.110	76	0.901	0.007	0.092	74	0.885	0.115	77	0.526	0.474
Nulato														
Mainstem	1987	61	0.918	0.082	60	0.933	0.000	0.067	61	0.885	0.115	61	0.500	0.500
South Fork	1987	71	0.887	0.113	65	0.939	0.000	0.062	71	0.887	0.113	71	0.472	0.528
North Fork	1988	50	0.880	0.120	50	0.900	0.000	0.100	50	0.850	0.150	50	0.490	0.510
	Pooled	182	0.896	0.104	175	0.926	0.000	0.074	182	0.876	0.124	182	0.486	0.514
Koyukuk														
Henshaw	1987	43	0.942	0.058	43	0.849	0.000	0.151	43	0.930	0.070	43	0.477	0.523
Jim	1987	101	0.871	0.129	101	0.866	0.000	0.134	90	0.900	0.100	100	0.440	0.560
Gisasa	1989	97	0.912	0.088	97	0.923	0.000	0.077	96	0.932	0.068	94	0.521	0.479
Mainstem-Early	1990	74	0.878	0.122	74	0.899	0.041	0.061	74	0.953	0.047	74	0.453	0.547
Mainstem-Late	1990	75	0.927	0.073	75	0.893	0.000	0.107	75	0.947	0.053	75	0.420	0.580
	Pooled	390	0.901	0.099	390	0.890	0.008	0.103	378	0.931	0.069	386	0.462	0.538
Tozitna	1989	85	0.900	0.100	85	0.865	0.000	0.135	84	0.935	0.066	85	0.512	0.488
Salcha	1988	48	0.958	0.042	48	0.896	0.000	0.104	50	0.950	0.050	48	0.510	0.490
	1989	50	0.880	0.120	50	0.920	0.010	0.070	50	0.950	0.050	50	0.460	0.540
	Pooled	98	0.918	0.082	98	0.908	0.005	0.087	100	0.950	0.050	98	0.485	0.515
United States Fall Run														
Toklat	1987	133	0.850	0.150	69	0.928	0.000	0.073	132	0.845	0.155*	135	0.270	0.730
	1990	74	0.858	0.142	74	0.892	0.000	0.108	74	0.912	0.088	74	0.284	0.716
	Pooled	207	0.853	0.147	143	0.909	0.000	0.091	206	0.869	0.131	209	0.275	0.725
Delta-Clearwater	1987	135	0.878	0.122	129	0.919	0.004	0.078	134	0.937	0.063	135	0.196	0.804
	1990	75	0.887	0.114	75	0.960	0.000	0.040	75	0.927	0.073	75	0.167	0.833
	Pooled	210	0.881	0.119	204	0.934	0.003	0.064	209	0.933	0.067	210	0.186	0.814
Bluff Cabin Slough	1987	135	0.878	0.122	71	0.937	0.000	0.063	133	0.921	0.079	134	0.198	0.802
Chandalar	1987	149	0.913	0.087	148	0.878	0.000	0.122	28	0.911	0.089	145	0.341	0.659
	1988	73	0.897	0.103	73	0.877	0.000	0.123	73	0.918	0.082	73	0.308	0.692
	1989	75	0.867	0.133	75	0.907	0.000	0.093	75	0.947	0.053	75	0.327	0.673
	Pooled	297	0.897	0.103	296	0.885	0.000	0.115	176	0.929	0.071	293	0.329	0.671
Sheenjek	1987	135	0.904	0.096	79	0.911	0.000	0.089	135	0.941	0.059	135	0.344	0.656
	1988	79	0.905	0.095	78	0.917	0.000	0.083	80	0.938	0.063	79	0.335	0.665
	1989	80	0.888	0.113	80	0.863	0.000	0.138	80	0.913	0.088	80	0.400	0.600
	Pooled	294	0.900	0.100	237	0.897	0.000	0.103	295	0.932	0.068	294	0.357	0.643
Canadian Fall Run														
Fishing Branch	1987	128	0.938	0.063	73	0.863	0.007	0.130	128	0.941	0.059	129	0.252	0.748
	1989	49	0.918	0.082	49	0.878	0.000	0.122	49	0.949	0.051	49	0.388	0.612
	Pooled	177	0.932	0.068	122	0.869	0.004	0.127	177	0.944	0.057	178	0.289	0.711
Big Creek	1987	69	0.877	0.123	37	0.960	0.000	0.041	69	0.935	0.065	69	0.283	0.717
Tatchun	1987	75	0.893	0.107	59	0.898	0.000	0.102	75	0.927	0.073	75	0.320	0.680
Minto	1989	100	0.930	0.070	100	0.920	0.000	0.080	100	0.955	0.045	100	0.345	0.655
Kluane	1987	133	0.895	0.105	66	0.909	0.000	0.091	145	0.969	0.031	143	0.255	0.745
Teslin	1989	95	0.905	0.095	95	0.868	0.005	0.126	95	0.963	0.037	95	0.568	0.432

Appendix VII. Continued.

Stock	Year	G3PDH-2 N	G3PDH-2 100	G3PDH-2 90	bGLUA N	bGLUA 100	bGLUA 64	mIDHP-1 N	mIDHP-1 100	mIDHP-1 60	sIDHP-2 N	sIDHP-2 100	sIDHP-2 35	sIDHP-2 85	sIDHP-2 25
United States Summer Run															
Andreafsky	1987	150	0.880	0.120	83	0.922	0.078	149	0.983	0.017	150	0.450	0.487	0.063	0.000
Chulinak	1989	97	0.871	0.129	99	0.924	0.076	99	0.965	0.035	97	0.428	0.521	0.041	0.010
Anvik	1987	149	0.829	0.171	124	0.919	0.081	150	0.990	0.010	149	0.453	0.483	0.064	0.000
	1988	100	0.860	0.140	99	0.909	0.091	99	0.970	0.030	100	0.500	0.460	0.035	0.005
Rodo	1989	77	0.948	0.052	77	0.890	0.110	77	0.987	0.013	77	0.435	0.487	0.078	0.000
Nulato															
Mainstem	1987	61	0.869	0.131	58	0.922	0.078	61	0.975	0.025	61	0.500	0.459	0.041	0.000
South Fork	1987	71	0.859	0.141	69	0.906	0.094	71	0.979	0.021	71	0.486	0.430	0.085	0.000
North Fork	1988	50	0.870	0.130	50	0.900	0.100	50	0.980	0.020	50	0.460	0.480	0.060	0.000
	Pooled	182	0.865	0.135	177	0.910	0.090	182	0.978	0.022	182	0.484	0.453	0.063	0.000
Koyukuk															
Henshaw	1987	43	0.872	0.128	38	0.921	0.079	43	0.965	0.035	43	0.500	0.430	0.070	0.000
Jim	1987	101	0.891	0.109	84	0.935	0.066	101	0.960	0.040	101	0.500	0.470	0.030	0.000
Gisasa	1989	91	0.929	0.071	97	0.928	0.072	97	0.990	0.010	97	0.485	0.454	0.062	0.000
Mainstem-Early	1990	73	0.932	0.069	73	0.932	0.069	74	0.953	0.047	74	0.554	0.378	0.068	0.000
Mainstem-Late	1990	75	0.893	0.107	75	0.927	0.073	75	0.980	0.020	75	0.533	0.400	0.067	0.000
	Pooled	383	0.906	0.094	367	0.929	0.071	390	0.971	0.030	390	0.513	0.431	0.056	0.000
Tozitna	1989	85	0.882	0.118	77	0.935	0.065	85	0.977	0.024	85	0.524	0.400	0.071	0.006
Salcha	1988	48	0.813	0.188	49	0.959	0.041	48	0.927	0.073	48	0.521	0.448	0.031	0.000
	1989	50	0.940	0.060	50	0.930	0.070	50	0.960	0.040	50	0.530	0.400	0.070	0.000
	Pooled	98	0.878	0.122	99	0.944	0.056	98	0.944	0.056	98	0.526	0.424	0.051	0.000
United States Fall Run															
Toklat	1987	134	0.787	0.213	75	0.920	0.080	135	0.956	0.044	135	0.633	0.304	0.063	0.000*
	1990	73	0.836	0.164	73	0.945	0.055	74	0.953	0.047	74	0.615	0.338	0.047	0.000
	Pooled	207	0.804	0.196	148	0.932	0.068	209	0.955	0.046	209	0.627	0.316	0.057	0.000
Delta-Clearwater	1987	135	0.863	0.137	117	0.966	0.034	135	0.982	0.019	135	0.533	0.407	0.059	0.000
	1990	75	0.840	0.160	74	0.932	0.068	75	0.987	0.013	75	0.540	0.440	0.020	0.000
	Pooled	210	0.855	0.145	191	0.953	0.047	210	0.983	0.017	210	0.536	0.419	0.045	0.000
Bluff Cabin Slough	1987	134	0.843	0.157	82	0.933	0.067	135	0.985	0.015	135	0.556	0.385	0.059	0.000*
Chandalar	1987	148	0.865	0.135	52	0.962	0.039	149	0.990	0.010	149	0.416	0.544	0.040	0.000
	1988	73	0.849	0.151	71	0.916	0.085	73	0.993	0.007	73	0.390	0.569	0.041	0.000
	1989	75	0.900	0.100	75	0.907	0.093	75	0.993	0.007	75	0.440	0.513	0.047	0.000
	Pooled	296	0.870	0.130	198	0.924	0.076	297	0.992	0.008	297	0.416	0.542	0.042	0.000
Sheenjek	1987	134	0.881	0.119	32	0.969	0.031	135	0.982	0.019	135	0.400	0.563	0.037	0.000
	1988	78	0.891	0.109	80	0.881	0.119	79	1.000	0.000	78	0.314	0.628	0.058	0.000
	1989	80	0.863	0.138	80	0.913	0.088	80	0.981	0.019	80	0.381	0.550	0.069	0.000
	Pooled	292	0.878	0.122	192	0.909	0.091	294	0.986	0.014	293	0.372	0.577	0.051	0.000
Canadian Fall Run															
Fishing Branch	1987	128	0.848	0.152	30	0.983	0.017	129	0.996	0.004	122	0.414	0.557	0.029	0.000***
	1989	49	0.847	0.153	48	0.938	0.063	49	1.000	0.000	49	0.357	0.602	0.041	0.000
	Pooled	177	0.848	0.153	78	0.955	0.045	178	0.997	0.003	171	0.398	0.570	0.032	0.000
Big Creek	1987	69	0.891	0.109	31	0.968	0.032	69	1.000	0.000	69	0.406	0.573	0.022	0.000*
Tatchun	1987	74	0.892	0.108	24	0.979	0.021	75	1.000	0.000	73	0.452	0.507	0.041	0.000
Minto	1989	100	0.875	0.125	100	0.965	0.035	100	1.000	0.000	100	0.475	0.485	0.040	0.000
Kluane	1987	134	0.828	0.172	31	0.774	0.226	135	1.000	0.000	135	0.344	0.596	0.059	0.000
Teslin	1989	94	0.973	0.027	93	0.957	0.043	95	1.000	0.000	95	0.626	0.337	0.037	0.000

Appendix VII. Continued.

Stock	Year	LDH-A1 N	LDH-A1 -100	LDH-A1 50	sMDH-A1 N	sMDH-A1 100	sMDH-A1 200	sMDH-A2 N	sMDH-A2 100	sMDH-A2 40	sMDH-B1,2 N	sMDH-B1,2 100	sMDH-B1,2 72	sMDH-B1,2 130/50
United States Summer Run														
Andreafsky	1987	150	0.827	0.173	150	0.947	0.053	149	0.963	0.037	150	0.993	0.007	0.000
Chulinak	1989	99	0.793	0.207	98	0.954	0.046	99	0.985	0.015	99	0.975	0.025	0.000
Anvik	1987	150	0.840	0.160	150	0.960	0.040	150	0.990	0.010	150	0.987	0.010	0.003
	1988	100	0.750	0.250	99	0.894	0.106	50	0.980	0.020	100	0.980	0.010	0.010
Rodo	1989	77	0.825	0.175	77	0.935	0.065	77	0.987	0.013	77	0.981	0.020	0.000
Nulato														
Mainstem	1987	61	0.795	0.205	61	0.934	0.066	61	1.000	0.000	61	0.992	0.008	0.000
South Fork	1987	71	0.711	0.289	71	0.951	0.035	71	0.951	0.049	71	0.979	0.021	0.000
North Fork	1988	50	0.690	0.310	50	0.940	0.060	50	0.970	0.030	50	0.990	0.000	0.010
	Pooled	182	0.734	0.267	182	0.948	0.052	182	0.973	0.028	182	0.986	0.011	0.003
Koyukuk														
Henshaw	1987	43	0.802	0.198	43	0.919	0.081	43	0.977	0.023	43	0.977	0.023	0.000
Jim	1987	101	0.753	0.248	101	0.886	0.114	101	0.946	0.055	101	0.946	0.045	0.010
Gisasa	1989	97	0.768	0.232	97	0.902	0.098	97	0.969	0.031	97	0.990	0.010	0.000
Mainstem-Early	1990	74	0.737	0.264	74	0.939	0.061	74	1.000	0.000	74	0.987	0.014	0.000
Mainstem-Late	1990	75	0.807	0.193	75	0.933	0.067	75	0.993	0.007	75	0.987	0.013	0.000
	Pooled	390	0.769	0.231	390	0.913	0.087	390	0.974	0.026	390	0.976	0.022	0.003
Tozitna	1989	85	0.771	0.229	85	0.959	0.041	85	0.965	0.035	85	0.959	0.041	0.000
Salcha	1988	48	0.719	0.281	48	0.969	0.031	48	1.000	0.000	48	0.958	0.042	0.000
	1989	50	0.790	0.210	50	0.950	0.050	48	0.990	0.010	50	0.950	0.040	0.010
	Pooled	98	0.755	0.245	98	0.959	0.041	96	0.995	0.005	98	0.954	0.041	0.005
United States Fall Run														
Toklat	1987	135	0.756	0.244	135	0.930	0.070	135	0.978	0.022	135	0.985	0.015	0.000
	1990	72	0.757	0.243	74	0.939	0.061	74	0.987	0.014	74	1.000	0.000	0.000
	Pooled	207	0.756	0.244	209	0.933	0.067	209	0.981	0.019	209	0.990	0.010	0.000
Delta-Clearwater	1987	135	0.704	0.296	130	0.939	0.062	135	0.993	0.007	135	1.000	0.000	0.000
	1990	74	0.669	0.331	75	0.933	0.067	75	0.973	0.027	75	1.000	0.000	0.000
	Pooled	209	0.691	0.309	205	0.937	0.063	210	0.986	0.014	210	1.000	0.000	0.000
Bluff Cabin Slough	1987	135	0.656	0.344**	135	0.944	0.056	135	0.989	0.011	135	1.000	0.000	0.000
Chandalar	1987	149	0.711	0.289	149	0.826	0.175	149	0.983	0.017	149	0.990	0.010	0.000
	1988	72	0.792	0.208	73	0.918	0.082	73	0.980	0.021	73	0.993	0.007	0.000
	1989	75	0.673	0.327	75	0.907	0.093	75	0.967	0.033	75	1.000	0.000	0.000
	Pooled	296	0.721	0.279	297	0.869	0.131	297	0.978	0.022	297	0.993	0.007	0.000
Sheenjek	1987	135	0.696	0.304	135	0.870	0.130	135	0.970	0.030	135	1.000	0.000	0.000
	1988	77	0.760	0.240*	79	0.854	0.146	79	0.956	0.044	79	1.000	0.000	0.000
	1989	80	0.650	0.350	80	0.900	0.100	80	0.981	0.019	80	0.994	0.006	0.000
	Pooled	292	0.700	0.300	294	0.874	0.126	294	0.969	0.031	294	0.998	0.002	0.000
Canadian Fall Run														
Fishing Branch	1987	129	0.632	0.368	129	0.930	0.070	126	0.968	0.032	129	1.000	0.000	0.000
	1989	49	0.643	0.357	49	0.929	0.071	49	0.990	0.010	49	1.000	0.000	0.000
	Pooled	178	0.635	0.365	178	0.930	0.070	175	0.974	0.026	178	1.000	0.000	0.000
Big Creek	1987	69	0.696	0.304	69	0.891	0.109	69	0.957	0.044	69	1.000	0.000	0.000
Tatchun	1987	75	0.713	0.287	71	0.866	0.134	75	0.933	0.067	75	1.000	0.000	0.000
Minto	1989	100	0.710	0.290	100	0.915	0.085	100	0.990	0.010	100	1.000	0.000	0.000
Kluane	1987	135	0.533	0.467	135	0.948	0.052	134	0.985	0.015	135	0.996	0.004	0.000
Teslin	1989	95	0.700	0.300	95	0.842	0.158	94	0.957	0.043	95	1.000	0.000	0.000

Appendix VII. Continued.

Stock	Year	mMEP-2			MPI			PEP-LT			PGDH		
		N	100	122	N	100	94	N	100	85	N	100	92
United States Summer Run													
Andreafsky	1987	150	0.807	0.193	150	0.837	0.163	46	0.957	0.044	146	0.956	0.045
Chulinak	1989	99	0.823	0.177	99	0.879	0.121	99	0.960	0.040	99	0.950	0.051
Anvik	1987	150	0.827	0.173	150	0.883	0.117	149	0.987	0.013	150	0.980	0.020
	1988	100	0.740	0.260	100	0.870	0.130	98	0.985	0.015	92	0.935	0.065
Rodo	1989	77	0.792	0.208	77	0.883	0.117	77	0.981	0.020	77	0.955	0.046
Nulato													
Mainstem	1987	61	0.787	0.213	61	0.853	0.148	61	0.951	0.049	61	0.918	0.082
South Fork	1987	71	0.754	0.247	71	0.901	0.099	50	0.990	0.010	71	0.951	0.049
North Fork	1988	50	0.830	0.170	50	0.820	0.180	50	0.980	0.020	50	0.980	0.020
	Pooled	182	0.786	0.214	182	0.863	0.137	161	0.972	0.028	182	0.948	0.052
Koyukuk													
Henshaw	1987	43	0.919	0.081	43	0.895	0.105	43	0.977	0.023	43	0.942	0.058
Jim	1987	101	0.921	0.079	101	0.916	0.084	101	0.965	0.035	101	0.951	0.050
Gisasa	1989	97	0.809	0.191	97	0.918	0.083	97	0.985	0.016	97	0.974	0.026
Mainstem-Early	1990	74	0.919	0.081	74	0.885	0.115	74	1.000	0.000	74	0.973	0.027
Mainstem-Late	1990	75	0.907	0.093	75	0.947	0.053	75	0.973	0.027	75	0.953	0.047
	Pooled	390	0.890	0.110	390	0.914	0.086	390	0.980	0.021	390	0.960	0.040
Tozitna	1989	85	0.871	0.129	85	0.900	0.100	85	0.982	0.018	85	0.941	0.059
Salcha	1988	48	0.927	0.073	48	0.896	0.104	50	0.990	0.010	48	0.958	0.042
	1989	50	0.850	0.150	50	0.930	0.070	50	0.980	0.020	50	0.940	0.060
	Pooled	98	0.888	0.112	98	0.913	0.087	100	0.985	0.015	98	0.949	0.051
United States Fall Run													
Toklat	1987	135	0.878	0.122	135	0.937	0.063	126	0.992	0.008	135	0.959	0.041
	1990	73	0.932	0.069	75	0.939	0.061	74	0.987	0.014	74	0.987	0.014
	Pooled	208	0.897	0.103	209	0.938	0.062	200	0.990	0.010	209	0.969	0.031
Delta-Clearwater	1987	135	0.907	0.093	132	0.943	0.057	134	0.963	0.037	135	0.978	0.014
	1990	75	0.873	0.127	75	0.933	0.067	75	0.973	0.027	75	0.960	0.040
	Pooled	210	0.895	0.105	207	0.940	0.060	209	0.967	0.034	210	0.971	0.029
Bluff Cabin Slough	1987	135	0.915	0.085	135	0.933	0.067	123	0.947	0.053	135	0.956	0.044
Chandalar	1987	149	0.909	0.091	149	0.930	0.071	146	0.969	0.031	136	0.974	0.026
	1988	73	0.925	0.075	73	0.938	0.062	73	0.993	0.007	73	0.980	0.021
	1989	75	0.893	0.107	75	0.887	0.113	75	1.000	0.000	75	0.973	0.027
	Pooled	297	0.909	0.091	297	0.921	0.079	294	0.983	0.017	284	0.975	0.025
Sheenjek	1987	135	0.911	0.089	135	0.896	0.104	124	0.980	0.020	135	0.974	0.026
	1988	79	0.956	0.044	79	0.892	0.108	80	0.969	0.031	79	0.968	0.032
	1989	80	0.956	0.044	80	0.856	0.144	80	0.994	0.006	80	0.969	0.031
	Pooled	294	0.935	0.065	294	0.884	0.116	284	0.981	0.019	294	0.971	0.029
Canadian Fall Run													
Fishing Branch	1987	128	0.934	0.066	126	0.913	0.087	23	0.935	0.065	129	0.973	0.027
	1989	49	0.939	0.061	49	0.898	0.102	49	0.980	0.020	49	0.980	0.020
	Pooled	177	0.935	0.065	175	0.909	0.091	72	0.965	0.035	178	0.975	0.025
Big Creek	1987	69	0.877	0.123	69	0.949	0.051	69	0.957	0.044	69	0.949	0.051
Tatchun	1987	75	0.900	0.100	75	0.913	0.087	75	0.967	0.033	75	0.967	0.033
Minto	1989	100	0.930	0.070	100	0.950	0.050	100	0.970	0.030	100	0.965	0.035
Kluane	1987	135	0.985	0.015	142	0.947	0.053	125	0.992	0.008	135	1.000	0.000
Teslin	1989	95	0.916	0.084	95	0.968	0.032	95	0.816	0.184	95	1.000	0.000

Appendix VII. Continued.

Stock	Year	PEPB-1 N	PEPB-1 -100	PEPB-1 -156	PEPB-1 -128	PEPB-1 -127	PEPB-2 N	PEPB-2 100	PEPB-2 132	TPI-1 N	TPI-1 -100	TPI-1 -50
United States Summer Run												
Andreafsky	1987	150	0.943	0.043	0.013	0.000	69	0.862	0.138	51	1.000	0.000
Chulinak	1989	99	0.960	0.035	0.005	0.000	99	0.939	0.061	99	1.000	0.000
Anvik	1987	150	0.927	0.067	0.007	0.000	115	0.913	0.087	106	1.000	0.000
	1988	100	0.935	0.045	0.020	0.000	99	0.773	0.227	100	0.995	0.005
Rodo	1989	77	0.909	0.058	0.026	0.007	77	0.903	0.097	77	1.000	0.000
Nulato												
Mainstem	1987	61	0.902	0.090	0.008	0.000	58	0.922	0.078	61	1.000	0.000
South Fork	1987	71	0.930	0.056	0.014	0.000	69	0.862	0.138	71	1.000	0.000
North Fork	1988	50	0.880	0.090	0.030	0.000	50	0.930	0.070	50	0.990	0.010
	Pooled	182	0.907	0.077	0.017	0.000	177	0.901	0.099	182	0.997	0.003
Koyukuk												
Henshaw	1987	43	0.919	0.070	0.012	0.000	43	0.907	0.093	43	1.000	0.000
Jim	1987	101	0.876	0.124	0.000	0.000	100	0.915	0.085	91	1.000	0.000
Gisasa	1989	97	0.912	0.083	0.005	0.000	97	0.897	0.103	97	1.000	0.000
Mainstem-Early	1990	74	0.885	0.108	0.007	0.000	74	0.858	0.142	74	1.000	0.000
Mainstem-Late	1990	75	0.847	0.133	0.020	0.000	75	0.900	0.100	75	1.000	0.000
	Pooled	390	0.886	0.106	0.008	0.000	389	0.896	0.104	380	1.000	0.000
Tozitna	1989	85	0.847	0.141	0.012	0.000	85	0.859	0.141	85	1.000	0.000
Salcha	1988	48	0.896	0.094	0.010	0.000	48	0.885	0.115	50	1.000	0.000
	1989	50	0.910	0.060	0.030	0.000	50	0.840	0.160	50	1.000	0.000
	Pooled	98	0.903	0.077	0.020	0.000	98	0.862	0.138	100	1.000	0.000
United States Fall Run												
Toklat	1987	135	0.789	0.182	0.030	0.000	86	0.919	0.081	85	1.000	0.000
	1990	74	0.757	0.216	0.027	0.000	73	0.904	0.096	74	1.000	0.000
	Pooled	209	0.778	0.194	0.029	0.000	159	0.912	0.088	159	1.000	0.000
Delta-Clearwater	1987	135	0.796	0.182	0.022	0.000	65	0.915	0.085	135	1.000	0.000
	1990	75	0.820	0.167	0.013	0.000	75	0.913	0.087	75	1.000	0.000
	Pooled	210	0.805	0.176	0.019	0.000	140	0.914	0.086	210	1.000	0.000
Bluff Cabin Slough	1987	135	0.852	0.130	0.019	0.000	75	0.920	0.080	135	1.000	0.000
Chandalar	1987	149	0.785	0.191	0.024	0.000	33	0.879	0.121	150	1.000	0.000
	1988	73	0.781	0.212	0.007	0.000	73	0.829	0.171	72	1.000	0.000
	1989	75	0.820	0.173	0.007	0.000	75	0.893	0.107	75	1.000	0.000
	Pooled	297	0.793	0.192	0.015	0.000	181	0.865	0.135	297	1.000	0.000
Sheenjek	1987	135	0.830	0.163	0.007	0.000	87	0.793	0.207	87	1.000	0.000
	1988	79	0.810	0.177	0.013	0.000	78	0.859	0.141	80	1.000	0.000
	1989	80	0.756	0.231	0.013	0.000	80	0.863	0.138	80	1.000	0.000
	Pooled	294	0.804	0.185	0.010	0.000	245	0.837	0.163	247	1.000	0.000
Canadian Fall Run												
Fishing Branch	1987	129	0.845	0.151	0.004	0.000	71	0.937	0.063	127	1.000	0.000
	1989	49	0.827	0.174	0.000	0.000	49	0.867	0.133	49	1.000	0.000
	Pooled	178	0.840	0.157	0.003	0.000	120	0.908	0.092	176	1.000	0.000
Big Creek	1987	69	0.797	0.203	0.000	0.000	45	0.967	0.033	63	1.000	0.000
Tatchun	1987	74	0.811	0.182	0.007	0.000	66	0.886	0.114	66	1.000	0.000
Minto	1989	100	0.860	0.135	0.005	0.000	100	0.870	0.130	100	1.000	0.000
Kluane	1987	143	0.888	0.112	0.000	0.000	91	0.868	0.132	144	1.000	0.000
Teslin	1989	95	0.853	0.147	0.000	0.000	95	0.790	0.211	95	1.000	0.000

Appendix VIII. Allelic frequencies at 22 polymorphic loci for chinook salmon sampled from the Yukon River drainage during 1987–1990. The most common allele is designated as 100, and other alleles assigned numbers according to their mobility relative to the 100 allele. N is the sample size. Allele designatiors separated by a slash indicates that the data for those alleles were pooled. An asterisk indicates significant deviation from Hardy-Weinberg Equilibrium (* = p < 0.05, ** = p < 0.01, and *** = p < 0.001).

		sAAT-3			sAAT-4				ADA-1			sAH			
Stock	Year	N	100	90	N	100	130	63	N	100	83	N	100	86	108
Andreafsky	1988	92	0.832	0.169	90	0.961	0.000	0.039	98	0.867	0.133	100	0.950	0.050	0.000
Anvik	1987	37	0.824	0.176	27	0.963	0.000	0.037	40	0.838	0.163	39	0.974	0.026	0.000
	1988	48	0.792	0.208	53	0.915	0.047	0.038	59	0.881	0.119	57	0.956	0.044	0.000
	Pooled	85	0.806	0.194	80	0.931	0.031	0.038	99	0.864	0.136	96	0.964	0.037	0.000
Nulato															
South Fork	1988	46	0.794	0.207	46	0.913	0.022	0.065	49	0.888	0.112	50	0.970	0.030	0.000
North Fork	1988	49	0.806	0.194	44	0.989	0.000	0.011	49	0.837	0.163	50	0.950	0.050	0.000
	Pooled	95	0.800	0.200	90	0.950	0.011	0.039	98	0.862	0.138	100	0.960	0.040	0.000
Gisasa	1987	47	0.681	0.319	43	0.977	0.000	0.023	47	0.830	0.170	47	0.968	0.032	0.000
	1988	89	0.770	0.230	90	0.922	0.072	0.006	90	0.817	0.183	91	0.962	0.039	0.000
	Pooled	136	0.739	0.261	133	0.940	0.049	0.011	137	0.821	0.179	138	0.964	0.036	0.000
Henshaw	1987	87	0.684	0.316	79	0.994	0.000	0.006	82	0.994	0.006	86	1.000	0.000	0.000
Jim	1987	79	0.715	0.285	78	0.974	0.013	0.013	75	0.967	0.033	78	0.987	0.013	0.000
	Pooled	166	0.699	0.301	157	0.984	0.006	0.010	157	0.981	0.019	164	0.994	0.006	0.000
South Fork Koyukuk	1987	84	0.649	0.351	82	0.994	0.000	0.006	81	0.969	0.031	88	0.994	0.006	0.000
Salcha	1988	95	0.690	0.311	99	0.995	0.000	0.005	97	1.000	0.000	100	1.000	0.000	0.000
Chena	1987	136	0.610	0.390	131	1.000	0.000	0.000	140	1.000	0.000	138	1.000	0.000	0.000
	1988	98	0.592	0.408	96	0.969	0.000	0.031	98	1.000	0.000	98	1.000	0.000	0.000
	Pooled	234	0.603	0.397	227	0.987	0.000	0.013	238	1.000	0.000	236	1.000	0.000	0.000
North Klondike	1989	39	0.923	0.077	44	0.966	0.000	0.034	40	0.988	0.013	44	0.943	0.057	0.000
	1990	150	0.880	0.120	150	0.973	0.000	0.027	150	0.990	0.010	150	0.963	0.023	0.000
	Pooled	189	0.889	0.111	194	0.972	0.000	0.028	190	0.990	0.011	194	0.959	0.031	0.000
McQuesten	1989	38	0.776	0.224	38	0.895	0.000	0.105	38	0.934	0.066	38	0.934	0.053	0.013
	1990	199	0.837	0.163	200	0.873	0.000	0.128	200	0.883	0.118	200	0.943	0.058	0.000
	Pooled	237	0.827	0.173	238	0.876	0.000	0.124	238	0.891	0.109	238	0.941	0.057	0.002
Pelly															
Ross	1988	14	0.679	0.321	13	0.923	0.000	0.077	13	1.000	0.000	14	0.964	0.036	0.000
	1989	30	0.667	0.333	29	0.862	0.000	0.138	30	0.983	0.017	29	0.862	0.121	0.017
Blind	1989	138	0.652	0.348	149	0.913	0.000	0.087	150	0.987	0.013	150	0.917	0.047	0.037
	Pooled	182	0.657	0.343	191	0.906	0.000	0.094	193	0.987	0.013	193	0.912	0.057	0.031
Tatchun	1988	44	0.659	0.341	43	0.930	0.000	0.070	47	0.979	0.021	44	0.909	0.080	0.011
	1989	29	0.741	0.259	18	0.889	0.000	0.111	29	0.983	0.017	29	0.931	0.069	0.000
	Pooled	73	0.692	0.308	61	0.918	0.000	0.082	76	0.980	0.020	73	0.918	0.075	0.007
Big Salmon	1988	49	0.704	0.296	46	0.859	0.000	0.141	49	0.959	0.041	49	0.827	0.174	0.000
	1989	77	0.864	0.136	77	0.909	0.000	0.091	77	0.948	0.052	78	0.821	0.160	0.019
	Pooled	126	0.802	0.198	123	0.890	0.000	0.110	126	0.952	0.048	127	0.823	0.165	0.012
Little Salmon	1988	32	0.922	0.078	28	0.893	0.000	0.107	29	0.931	0.069	28	0.821	0.179	0.000
	1989	27	0.741	0.259	25	0.840	0.100	0.060	27	0.963	0.037	27	0.833	0.167	0.000
Bear Feed	1989	87	0.828	0.172	85	0.777	0.012	0.212	87	0.937	0.063	87	0.868	0.132	0.000
	Pooled	146	0.832	0.168	138	0.812	0.025	0.163	143	0.941	0.059	142	0.852	0.148	0.000
Takhini	1988	24	0.854	0.146	24	0.792	0.000	0.208	25	0.960	0.040	24	0.521	0.479	0.000
	1990	25	0.780	0.220	25	0.900	0.000	0.100	25	0.920	0.080	25	0.600	0.400	0.000
Stony	1990	119	0.861	0.139	121	0.930	0.000	0.070	121	0.967	0.033	121	0.624	0.376	0.000
	Pooled	168	0.848	0.152	170	0.906	0.000	0.094	171	0.959	0.041	170	0.606	0.394	0.000
Nisutlin	1989	70	0.714	0.286	70	0.950	0.021	0.029	70	1.000	0.000	70	0.779	0.221	0.000

Appendix VIII. Continued.

Stock	Year	ALAT N	ALAT 100	ALAT 94	GPI-B1 N	GPI-B1 100	GPI-B1 24	IDDH-1 N	IDDH-1 100	IDDH-1 0	sIDHP-1 N	sIDHP-1 100	sIDHP-1 74	sIDHP-1 136
Andreafsky	1988	100	0.890	0.110	100	1.000	0.000	99	0.955	0.046	100	1.000	0.000	0.000
Anvik	1987	40	0.888	0.113	40	1.000	0.000	39	0.962	0.039	38	0.987	0.013	0.000
	1988	60	0.917	0.083	55	1.000	0.000	60	1.000	0.000	58	0.991	0.009	0.000
	Pooled	100	0.905	0.095	95	1.000	0.000	99	0.985	0.015	96	0.990	0.010	0.000
Nulato														
South Fork	1988	50	0.890	0.110	50	1.000	0.000	44	0.989	0.011	50	0.990	0.000	0.010
North Fork	1988	50	0.940	0.060	50	1.000	0.000	50	0.970	0.030	50	1.000	0.000	0.000
	Pooled	100	0.915	0.085	100	1.000	0.000	94	0.979	0.021	100	0.995	0.000	0.005
Gisasa	1987	47	0.894	0.106	47	1.000	0.000	47	0.979	0.021	47	1.000	0.000	0.000
	1988	88	0.869	0.131	91	1.000	0.000	88	0.977	0.023	91	1.000	0.000	0.000
	Pooled	135	0.878	0.122	138	1.000	0.000	135	0.978	0.022	138	1.000	0.000	0.000
Henshaw	1987	86	0.895	0.105	87	1.000	0.000	39	0.962	0.039	87	1.000	0.000	0.000
Jim	1987	78	0.962	0.039	77	1.000	0.000	29	0.983	0.017	78	1.000	0.000	0.000
	Pooled	164	0.927	0.073	164	1.000	0.000	68	0.971	0.029	165	1.000	0.000	0.000
South Fork Koyukuk	1987	83	0.898	0.102	87	1.000	0.000	50	1.000	0.000	87	1.000	0.000	0.000
Salcha	1988	100	0.925	0.075	100	1.000	0.000	95	0.942	0.058	100	1.000	0.000	0.000
Chena	1987	134	0.944	0.056	140	1.000	0.000	121	0.946	0.054	145	1.000	0.000	0.000
	1988	98	0.944	0.056	98	1.000	0.000	94	0.968	0.032	98	1.000	0.000	0.000
	Pooled	232	0.944	0.026	238	1.000	0.000	215	0.956	0.044	243	1.000	0.000	0.000
North Klondike	1989	40	0.750	0.250	40	1.000	0.000	44	0.932	0.068	40	1.000	0.000	0.000
	1990	150	0.913	0.087	150	1.000	0.000	150	0.963	0.037	150	1.000	0.000	0.000
	Pooled	190	0.879	0.121	190	1.000	0.000	194	0.956	0.044	190	1.000	0.000	0.000
McQuesten	1989	38	0.921	0.079	38	1.000	0.000	38	0.947	0.053	38	1.000	0.000	0.000
	1990	199	0.950	0.050	199	0.990	0.010	200	0.960	0.040	200	1.000	0.000	0.000
	Pooled	237	0.945	0.055	237	0.992	0.008	238	0.958	0.042	238	1.000	0.000	0.000
Pelly														
Ross	1988	14	1.000	0.000	13	1.000	0.000	14	0.929	0.071	14	1.000	0.000	0.000
	1989	30	1.000	0.000	30	0.900	0.100	29	0.879	0.121	30	1.000	0.000	0.000
Blind	1989	150	0.997	0.003	150	0.980	0.020	150	0.970	0.030	150	1.000	0.000	0.000
	Pooled	194	0.997	0.003	193	0.969	0.031	193	0.953	0.047	194	1.000	0.000	0.000
Tatchun	1988	46	1.000	0.000	49	1.000	0.000	14	0.990	0.010	49	1.000	0.000	0.000
	1989	29	1.000	0.000	29	1.000	0.000	19	0.974	0.026	10	1.000	0.000	0.000
	Pooled	75	1.000	0.000	78	1.000	0.000	67	0.985	0.015	59	1.000	0.000	0.000
Big Salmon	1988	47	0.989	0.011	49	1.000	0.000	49	0.969	0.031	49	1.000	0.000	0.000
	1989	75	0.973	0.027	78	1.000	0.000	77	0.974	0.026	75	1.000	0.000	0.000
	Pooled	122	0.980	0.021	127	1.000	0.000	126	0.972	0.028	124	1.000	0.000	0.000
Little Salmon	1988	33	0.970	0.030	29	1.000	0.000	34	0.941	0.059	32	1.000	0.000	0.000
	1989	27	0.963	0.037	27	1.000	0.000	27	0.982	0.019	27	1.000	0.000	0.000
Bear Feed	1989	87	0.989	0.012	87	0.994	0.06	87	0.960	0.040	87	1.000	0.000	0.000
	Pooled	147	0.980	0.020	143	0.997	0.004	148	0.960	0.041	146	1.000	0.000	0.000
Takhini	1988	25	1.000	0.000	25	1.000	0.000	25	0.960	0.040	25	1.000	0.000	0.000
	1990	25	0.980	0.020	25	1.000	0.000	25	0.960	0.040	25	1.000	0.000	0.000
Stony	1990	120	1.000	0.000	121	1.000	0.000	121	0.992	0.008	121	1.000	0.000	0.000
	Pooled	170	0.997	0.003	171	1.000	0.000	171	0.983	0.018	171	1.000	0.000	0.000
Nisutlin	1989	71	1.000	0.000	70	1.000	0.000	71	1.000	0.000	71	1.000	0.000	0.000

Appendix VIII. Continued.

Stock	Year	sIDHP-2 N	sIDHP-2 100	sIDHP-2 127	sIDHP-2 50/83	LDH-B2 N	LDH-B2 100	LDH-B2 71	sMDH-B1,2 N	sMDH-B1,2 100	sMDH-B1,2 121/126	sMDH-B1,2 70
Andreafsky	1988	97	0.959	0.000	0.041	100	1.000	0.000	100	0.995	0.005	0.000
Anvik	1987	38	1.000	0.000	0.000	40	1.000	0.000	40	0.975	0.025	0.000
	1988	58	0.966	0.000	0.035	60	1.000	0.000	60	0.983	0.017	0.000
	Pooled	96	0.979	0.000	0.021	100	1.000	0.000	100	0.980	0.020	0.000
Nulato												
South Fork	1988	50	0.980	0.000	0.020	50	1.000	0.000	50	0.960	0.040	0.000
North Fork	1988	50	0.950	0.000	0.050	50	1.000	0.000	50	0.990	0.010	0.000
	Pooled	100	0.965	0.000	0.035	100	1.000	0.000	100	0.975	0.025	0.000
Gisasa	1987	47	0.989	0.000	0.011	47	1.000	0.000	47	1.000	0.000	0.000
	1988	91	0.995	0.000	0.006	91	1.000	0.000	91	1.000	0.000	0.000
	Pooled	138	0.993	0.000	0.007	138	1.000	0.000	138	1.000	0.000	0.000
Henshaw	1987	86	0.997	0.000	0.023	87	1.000	0.000	87	0.937	0.058	0.006
Jim	1987	78	0.994	0.000	0.006	79	0.994	0.006	79	0.905	0.057	0.038
	Pooled	164	0.985	0.000	0.015	166	0.997	0.003	166	0.922	0.057	0.021
South Fork Koyukuk	1987	87	0.989	0.000	0.012	88	0.994	0.006	88	0.852	0.063	0.085
Salcha	1988	100	1.000	0.000	0.000	100	0.975	0.025	100	0.940	0.020	0.040
Chena	1987	145	0.997	0.003	0.000	151	0.987	0.013	149	0.896	0.050	0.054
	1988	98	1.000	0.000	0.000	98	0.990	0.010	98	0.908	0.041	0.051
	Pooled	243	0.998	0.002	0.000	249	0.988	0.012	247	0.901	0.047	0.053
North Klondike	1989	40	1.000	0.000	0.000	44	1.000	0.000	40	1.000	0.000	0.000
	1990	150	1.000	0.000	0.000	150	1.000	0.000	150	1.000	0.000	0.000
	Pooled	190	1.000	0.000	0.000	194	1.000	0.000	190	1.000	0.000	0.000
McQuesten	1989	38	1.000	0.000	0.000	38	1.000	0.000	38	0.987	0.013	0.000
	1990	200	1.000	0.000	0.000	200	1.000	0.000	200	1.000	0.000	0.000
	Pooled	238	1.000	0.000	0.000	238	1.000	0.000	238	0.998	0.002	0.000
Pelly												
Ross	1988	14	1.000	0.000	0.000	14	1.000	0.000	14	1.000	0.000	0.000
	1989	30	1.000	0.000	0.000	30	1.000	0.000	30	1.000	0.000	0.000
Blind	1989	150	0.997	0.003	0.000	150	1.000	0.000	150	1.000	0.000	0.000
	Pooled	194	0.997	0.003	0.000	194	1.000	0.000	194	1.000	0.000	0.000
Tatchun	1988	49	1.000	0.000	0.000	49	1.000	0.000	49	1.000	0.000	0.000
	1989	10	1.000	0.000	0.000	29	1.000	0.000	29	1.000	0.000	0.000
	Pooled	59	1.000	0.000	0.000	78	1.000	0.000	78	1.000	0.000	0.000
Big Salmon	1988	49	1.000	0.000	0.000	49	1.000	0.000	49	1.000	0.000	0.000
	1989	75	1.000	0.000	0.000	78	1.000	0.000	75	1.000	0.000	0.000
	Pooled	124	1.000	0.000	0.000	127	1.000	0.000	124	1.000	0.000	0.000
Little Salmon	1988	32	1.000	0.000	0.000	32	1.000	0.000	35	1.000	0.000	0.000
	1989	27	1.000	0.000	0.000	27	1.000	0.000	27	1.000	0.000	0.000
Bear Feed	1989	87	1.000	0.000	0.000	87	1.000	0.000	87	1.000	0.000	0.000
	Pooled	146	1.000	0.000	0.000	146	1.000	0.000	149	1.000	0.000	0.000
Takhini	1988	25	1.000	0.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000
	1990	25	1.000	0.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000
Stony	1990	121	0.992	0.004	0.004	121	1.000	0.000	121	1.000	0.000	0.000
	Pooled	171	0.994	0.003	0.003	171	1.000	0.000	171	1.000	0.000	0.000
Nisutlin	1989	64	1.000	0.000	0.000	71	1.000	0.000	71	1.000	0.000	0.000

Appendix VIII. Continued.

		sMEP-1[a]				sMEP-2			MPI			PEPA		
Stock	Year	N	100	92	86	N	100	78	N	100	109	N	100	90
Andreafsky	1988	100	0.005	0.995	0.000	100	0.880	0.120	100	0.925	0.075	100	0.950	0.050***
Anvik	1987	40	0.000	1.000	0.000	40	0.850	0.150	40	0.913	0.088	40	0.975	0.034
	1988	60	0.008	0.992	0.000	60	0.917	0.083	60	0.917	0.083	59	0.966	0.034
	Pooled	100	0.005	0.995	0.000	100	0.890	0.110	100	0.915	0.085	99	0.970	0.030
Nulato														
South Fork	1988	50	0.010	0.990	0.000	50	0.980	0.020	50	0.860	0.140	50	0.970	0.030
North Fork	1988	50	0.010	0.990	0.000	50	0.920	0.080	50	0.880	0.120***	50	0.940	0.060
	Pooled	100	0.010	0.990	0.000	100	0.950	0.050	100	0.870	0.130	100	0.955	0.045
Gisasa	1987	47	0.000	0.989	0.011	47	0.872	0.128	47	0.915	0.085	47	0.968	0.032
	1988	87	0.017	0.983	0.000	91	0.923	0.077	90	0.850	0.150	91	0.967	0.033
	Pooled	134	0.011	0.985	0.004	138	0.906	0.094	137	0.872	0.128	138	0.967	0.033
Henshaw	1987	86	0.064	0.930	0.006*	81	0.852	0.148	85	0.988	0.012	87	0.931	0.069
Jim	1987	71	0.035	0.937	0.028***	58	0.845	0.155	78	0.987	0.013	78	0.955	0.045
	Pooled	157	0.051	0.933	0.016	139	0.849	0.151	163	0.988	0.012	165	0.942	0.058
South Fork Koyukuk	1987	82	0.012	0.982	0.006	80	0.638	0.363	87	0.977	0.023	88	0.955	0.046
Salcha	1988	100	0.000	0.995	0.005	100	0.710	0.290	100	0.990	0.010	100	0.945	0.055
Chena	1987	150	0.000	0.993	0.007	149	0.805	0.195	149	0.983	0.017	147	0.966	0.034
	1988	98	0.000	0.990	0.010	98	0.725	0.276	98	0.995	0.005	98	0.969	0.031
	Pooled	248	0.000	0.992	0.008	247	0.773	0.227	247	0.988	0.012	245	0.967	0.033
North Klondike	1989	44	0.000	0.977	0.023	44	0.591	0.409	44	0.966	0.034	40	0.900	0.100
	1990	150	0.000	0.983	0.017	150	0.687	0.313	150	0.943	0.057	150	0.870	0.130
	Pooled	194	0.000	0.982	0.018	194	0.665	0.335	194	0.949	0.052	190	0.876	0.124
McQuesten	1989	38	0.000	1.000	0.000	38	0.684	0.316	38	0.868	0.132	38	0.908	0.092
	1990	200	0.000	0.970	0.030	200	0.725	0.275	200	0.945	0.055	200	0.893	0.108
	Pooled	238	0.000	0.975	0.025	238	0.719	0.282	238	0.933	0.067	238	0.895	0.105
Pelly														
Ross	1988	14	0.000	1.000	0.000	14	0.786	0.214	14	0.679	0.321	14	1.000	0.000
	1989	30	0.000	1.000	0.000	30	0.867	0.133	30	0.750	0.250	30	1.000	0.000
Blind	1989	150	0.003	0.997	0.000	150	0.867	0.133	150	0.840	0.160	150	0.997	0.003
	Pooled	194	0.003	0.997	0.000	194	0.861	0.139	194	0.814	0.186	194	0.997	0.003
Tatchun	1988	48	0.000	1.000	0.000	48	0.542	0.458	48	0.885	0.115	49	1.000	0.000
	1989	29	0.000	1.000	0.000	29	0.655	0.345	29	0.948	0.052	29	1.000	0.000
	Pooled	77	0.000	1.000	0.000	77	0.584	0.416	77	0.909	0.091	78	1.000	0.000
Big Salmon	1988	48	0.010	0.990	0.000	48	0.729	0.271	49	0.867	0.133	49	0.980	0.020
	1989	78	0.000	0.987	0.013	78	0.603	0.397	78	0.885	0.115	77	0.987	0.013
	Pooled	126	0.004	0.988	0.008	126	0.651	0.349	127	0.878	0.122	126	0.984	0.016
Little Salmon	1988	35	0.000	1.000	0.000	35	0.686	0.314	35	0.886	0.114	34	1.000	0.000
Bear Feed	1989	27	0.000	1.000	0.000	27	0.667	0.333	27	0.852	0.148	27	0.982	0.019
	1989	87	0.006	0.994	0.000	85	0.600	0.400	87	0.925	0.075	87	0.994	0.006
	Pooled	149	0.003	0.997	0.000	147	0.633	0.367	149	0.903	0.097	148	0.993	0.007
Takhini	1988	25	0.000	1.000	0.000	25	0.680	0.320	25	0.820	0.180	25	1.000	0.000
	1990	25	0.000	1.000	0.000	25	0.840	0.160	25	0.980	0.020	25	1.000	0.000
Stony	1990	121	0.000	1.000	0.000	121	0.727	0.273	121	0.901	0.099	121	1.000	0.000
	Pooled	171	0.000	1.000	0.000	171	0.737	0.263	171	0.901	0.099	171	1.000	0.000
Nisutlin	1989	68	0.015	0.963	0.022	71	0.747	0.254	71	0.887	0.113	70	1.000	0.000

Appendix VIII. Continued.

Stock	Year	PEPB-1 N	100	130	-350	60	PGM-1 N	100	210	50	mSOD-1 N	100	90
Andreafsky	1988	98	0.862	0.138	0.000	0.000	100	1.000	0.000	0.000	100	0.885	0.115
Anvik	1987	40	0.900	0.100	0.000	0.000	40	1.000	0.000	0.000	40	0.950	0.050
	1988	58	0.853	0.147	0.000	0.000	60	1.000	0.000	0.000	57	0.974	0.026
	Pooled	98	0.872	0.128	0.000	0.000	100	1.000	0.000	0.000	97	0.964	0.036
Nulato													
South Fork	1988	50	0.750	0.250	0.000	0.000	50	1.000	0.000	0.000	50	0.940	0.060
North Fork	1988	50	0.880	0.120	0.000	0.000	50	1.000	0.000	0.000	50	0.920	0.080
	Pooled	100	0.815	0.185	0.000	0.000	100	1.000	0.000	0.000	100	0.930	0.070
Gisasa	1987	47	0.798	0.192	0.000	0.011	47	1.000	0.000	0.000	47	0.894	0.106
	1988	89	0.837	0.163	0.000	0.000	91	1.000	0.000	0.000	89	0.921	0.088
	Pooled	136	0.824	0.173	0.000	0.004	138	1.000	0.000	0.000	136	0.912	0.088
Henshaw	1987	85	0.771	0.224	0.000	0.006	86	1.000	0.000	0.000	0	0.000	0.000
Jim	1987	75	0.800	0.193	0.000	0.007	78	1.000	0.000	0.000	62	0.936	0.065
	Pooled	160	0.784	0.209	0.000	0.006	164	1.000	0.000	0.000	62	0.936	0.065
South Fork Koyukuk	1987	85	0.747	0.253	0.000	0.000	88	1.000	0.000	0.000	67	0.873	0.127
Salcha	1988	100	0.780	0.215	0.005	0.000	99	1.000	0.000	0.000	100	0.915	0.085
Chena	1987	139	0.737	0.263	0.000	0.000	150	1.000	0.000	0.000	143	0.895	0.105
	1988	98	0.765	0.235	0.000	0.000	98	1.000	0.000	0.000	97	0.876	0.124
	Pooled	237	0.749	0.251	0.000	0.000	248	1.000	0.000	0.000	240	0.888	0.113
North Klondike	1989	40	0.938	0.063	0.000	0.000	40	1.000	0.000	0.000	44	1.000	0.000
	1990	150	0.920	0.080	0.000	0.000	150	0.997	0.000	0.003	0	0.000	0.000
	Pooled	190	0.924	0.076	0.000	0.000	190	0.997	0.000	0.003	44	1.000	0.000
McQuesten	1989	37	0.932	0.068	0.000	0.000	38	0.868	0.000	0.132	38	1.000	0.000
	1990	200	0.958	0.043	0.000	0.000	200	0.953	0.000	0.048	0	0.000	0.000
	Pooled	237	0.954	0.046	0.000	0.000	238	0.939	0.000	0.061	38	1.000	0.000
Pelly													
Ross	1988	14	1.000	0.000	0.000	0.000	14	1.000	0.000	0.000	14	0.929	0.071
	1989	30	0.983	0.017	0.000	0.000	30	1.000	0.000	0.000	30	0.983	0.017
Blind	1989	150	0.970	0.030	0.000	0.000	150	1.000	0.000	0.000	100	1.000	0.000
	Pooled	194	0.974	0.026	0.000	0.000	194	1.000	0.000	0.000	144	0.990	0.010
Tatchun	1988	49	0.969	0.000	0.010	0.020	48	1.000	0.000	0.000	47	0.926	0.075
	1989	29	1.000	0.000	0.000	0.000	29	1.000	0.000	0.000	29	0.897	0.103
	Pooled	78	0.981	0.000	0.006	0.013	77	1.000	0.000	0.000	76	0.915	0.086
Big Salmon	1988	48	0.990	0.000	0.010	0.000	49	1.000	0.000	0.000	49	0.939	0.061
	1989	74	0.973	0.020	0.000	0.007	78	1.000	0.000	0.000	78	1.000	0.000
	Pooled	122	0.980	0.012	0.004	0.004	127	1.000	0.000	0.000	127	0.976	0.024
Little Salmon	1988	35	1.000	0.000	0.000	0.000	35	1.000	0.000	0.000	34	0.956	0.044
	1989	27	0.982	0.000	0.000	0.019	27	0.982	0.000	0.019	27	1.000	0.000
Bear Feed	1989	87	1.000	0.000	0.000	0.000	87	1.000	0.000	0.000	74	0.987	0.014
	Pooled	149	0.997	0.000	0.000	0.003	149	0.997	0.000	0.003	135	0.982	0.019
Takhini	1988	25	1.000	0.000	0.000	0.000	25	1.000	0.000	0.000	25	0.940	0.060
	1990	25	1.000	0.000	0.000	0.000	25	1.000	0.000	0.000	24	0.854	0.146
Stony	1990	121	1.000	0.000	0.000	0.000	121	1.000	0.000	0.000	109	0.913	0.087
	Pooled	171	1.000	0.000	0.000	0.000	171	1.000	0.000	0.000	158	0.908	0.092
Nisutlin	1989	68	0.956	0.000	0.000	0.044	71	1.000	0.000	0.000	68	0.985	0.015

Appendix VIII. Continued.

Stock	Year	sSOD-1			TPI-1			TPI-2				TPI-4		
		N	-100	-260	N	-100	-121	N	-100	63	-400	N	100	104
Andreafsky	1988	94	0.942	0.059	100	1.000	0.000	100	1.000	0.000	0.000	99	0.919	0.081
Anvik	1987	40	0.975	0.025	40	1.000	0.000	40	1.000	0.000	0.000	40	0.900	0.100
	1988	60	0.975	0.025	60	1.000	0.000	60	1.000	0.000	0.000	60	0.892	0.108
	Pooled	100	0.975	0.025	100	1.000	0.000	100	1.000	0.000	0.000	100	0.895	0.105
Nulato														
South Fork	1988	49	0.939	0.061	50	1.000	0.000	50	1.000	0.000	0.000	50	0.880	0.120
North Fork	1988	50	0.970	0.030	49	1.000	0.000	49	1.000	0.000	0.000	50	0.950	0.050
	Pooled	99	0.955	0.046	99	1.000	0.000	99	1.000	0.000	0.000	100	0.915	0.085
Gisasa	1987	47	1.000	0.000	47	1.000	0.000	47	0.968	0.000	0.032	47	0.915	0.085
	1988	91	0.940	0.060	91	1.000	0.000	91	0.995	0.000	0.006	91	0.912	0.088
	Pooled	138	0.960	0.040	138	1.000	0.000	138	0.986	0.000	0.015	138	0.913	0.087
Henshaw	1987	81	0.988	0.012	87	1.000	0.000	87	1.000	0.000	0.000	87	0.902	0.098
Jim	1987	78	0.974	0.026	78	1.000	0.000	78	1.000	0.000	0.000	78	0.833	0.167
	Pooled	159	0.981	0.019	165	1.000	0.000	165	1.000	0.000	0.000	165	0.870	0.130
South Fork Koyukuk	1987	88	0.989	0.011	88	1.000	0.000	88	1.000	0.000	0.000	88	0.903	0.097
Salcha	1988	100	0.990	0.010	100	1.000	0.000	100	1.000	0.000	0.000	100	0.860	0.140
Chena	1987	148	0.953	0.047	141	1.000	0.000	141	1.000	0.000	0.000	139	0.889	0.112
	1988	97	0.990	0.010	98	1.000	0.000	98	1.000	0.000	0.000	98	0.888	0.112
	Pooled	245	0.967	0.033	239	1.000	0.000	239	1.000	0.000	0.000	237	0.888	0.112
North Klondike	1989	40	1.000	0.000	40	1.000	0.000	40	1.000	0.000	0.000	40	0.825	0.175
	1990	150	0.997	0.003	150	1.000	0.000	150	0.997	0.003	0.000	150	0.843	0.157
	Pooled	190	0.997	0.003	190	1.000	0.000	190	0.997	0.003	0.000	190	0.840	0.161
McQuesten	1989	38	1.000	0.000	38	1.000	0.000	38	1.000	0.000	0.000	38	0.974	0.026
	1990	200	1.000	0.000	200	1.000	0.000	200	0.998	0.003	0.000	200	0.898	0.103
	Pooled	238	1.000	0.000	238	1.000	0.000	238	0.998	0.002	0.000	238	0.910	0.090
Pelly														
Ross	1988	14	1.000	0.000	14	1.000	0.000	14	0.964	0.036	0.000	14	1.000	0.000
	1989	30	1.000	0.000	30	1.000	0.000	30	0.867	0.133	0.000	30	0.967	0.033
Blind	1989	150	1.000	0.000	150	1.000	0.000	150	0.940	0.060	0.000	150	0.997	0.003
	Pooled	194	1.000	0.000	194	1.000	0.000	194	0.930	0.070	0.000	194	0.992	0.008
Tatchun	1988	49	1.000	0.000	49	1.000	0.000	49	1.000	0.000	0.000	49	0.980	0.020
	1989	29	1.000	0.000	29	1.000	0.000	29	1.000	0.000	0.000	29	1.000	0.000
	Pooled	78	1.000	0.000	78	1.000	0.000	78	1.000	0.000	0.000	78	1.000	0.000
Big Salmon	1988	49	1.000	0.000	49	1.000	0.000	49	1.000	0.000	0.000	49	0.980	0.020
	1989	78	1.000	0.000	78	1.000	0.000	78	0.981	0.019	0.000	78	0.994	0.006
	Pooled	127	1.000	0.000	127	1.000	0.000	127	0.988	0.012	0.000	127	0.988	0.012
Little Salmon	1988	35	1.000	0.000	35	1.000	0.000	35	1.000	0.000	0.000	35	1.000	0.000
	1989	27	1.000	0.000	27	1.000	0.000	27	0.982	0.019	0.000	27	1.000	0.000
Bear Feed	1989	87	1.000	0.000	87	1.000	0.000	87	1.000	0.000	0.000	87	0.994	0.006
	Pooled	149	1.000	0.000	149	1.000	0.000	149	0.997	0.003	0.000	149	0.997	0.003
Takhini	1988	25	1.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000	25	1.000	0.000
	1990	25	1.000	0.000	25	1.000	0.000	25	1.000	0.000	0.000	25	1.000	0.000
Stony	1990	121	1.000	0.000	121	1.000	0.000	121	1.000	0.000	0.000	121	1.000	0.000
	Pooled	171	1.000	0.000	171	1.000	0.000	171	1.000	0.000	0.000	171	1.000	0.000
Nisutlin	1989	71	1.000	0.000	71	1.000	0.000	71	1.000	0.000	0.000	71	0.986	0.014

[a] The common allele for sMEP-1 in the Yukon River stocks is the alternative allele in California stocks of chinook salmon studied by Gall et al. (1989).

Appendix IX. Yukon River District 1 chum salmon harvest proportions by stock-grouping of origin in 1987. Estimates for 1987 were based on analysis of 12 loci.

	PERIOD # 1 JUNE 16 TO JUNE 19			PERIOD # 2 JUNE 23 TO JUNE 26		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.8812	0.7873	0.1143	0.7597	0.7228	0.1216
Mid-river Summer Run	0.0000	0.0423	0.0632	0.1841	0.1720	0.1318
Tanana River Fall Run	0.0000	0.0084	0.0247	0.0000	0.0173	0.0360
Chandalar/Sheenjek	0.0000	0.0039	0.0175	0.0555	0.0258	0.0487
Fishing Br./Canadian Mainstem	0.1188	0.1495	0.0915	0.0007	0.0556	0.0827
Upper Canadian Yukon	0.0000	0.0086	0.0204	0.0000	0.0064	0.0189
U.S. Summer Run	0.8812	0.8296	0.0903	0.9438	0.8949	0.0889
U.S. Fall Run	0.0000	0.0122	0.0293	0.0555	0.0431	0.0578
Canadian Fall Run	0.1188	0.1581	0.0886	0.0007	0.0620	0.0837
U.S.	0.8812	0.8418	0.0886	0.9993	0.9380	0.0837
Canada	0.1188	0.1581	0.0886	0.0007	0.0620	0.0837
Summer Run	0.8812	0.8296	0.0903	0.9438	0.8949	0.0889
Fall Run	0.1188	0.1703	0.0903	0.0562	0.1051	0.0889

	PERIOD # 3 JUNE 30 TO JULY 3			PERIOD # 4 JULY 6 TO JULY 11		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.6636	0.5512	0.1401	0.7745	0.7259	0.1360
Mid-river Summer Run	0.0926	0.2074	0.1445	0.2242	0.2119	0.1275
Tanana River Fall Run	0.0077	0.0106	0.0249	0.0000	0.0026	0.0112
Chandalar/Sheenjek	0.1756	0.1282	0.1033	0.0000	0.0136	0.0335
Fishing Br./Canadian Mainstem	0.0032	0.0551	0.0814	0.0013	0.0444	0.0590
Upper Canadian Yukon	0.0573	0.0474	0.0558	0.0000	0.0015	0.0086
U.S. Summer Run	0.7562	0.7587	0.1180	0.9987	0.9378	0.0643
U.S. Fall Run	0.1833	0.1388	0.1046	0.0000	0.0162	0.0345
Canadian Fall Run	0.0605	0.1025	0.1011	0.0013	0.0460	0.0600
U.S.	0.9395	0.8975	0.1014	0.9987	0.9540	0.0600
Canada	0.0605	0.1025	0.1014	0.0013	0.0460	0.0600
Summer Run	0.7562	0.7587	0.1180	0.9987	0.9378	0.0643
Fall Run	0.2438	0.2413	0.1180	0.0013	0.0622	0.0643

Appendix IX. (continued)

STOCK GROUPING	PERIOD # 5 JULY 13 TO JULY 19 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 21 TO JULY 27 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.4369	0.4131	0.1521	0.0181	0.0942	0.0892
Mid-river Summer Run	0.3923	0.3258	0.1818	0.3553	0.3136	0.1334
Tanana River Fall Run	0.1376	0.1499	0.1145	0.1238	0.1616	0.1099
Chandalar/Sheenjek	0.0332	0.0447	0.0710	0.0001	0.0316	0.0754
Fishing Br./Canadian Mainstem	0.0000	0.0508	0.0804	0.3994	0.2840	0.1412
Upper Canadian Yukon	0.0000	0.0157	0.0312	0.1034	0.1150	0.0785
U.S. Summer Run	0.8292	0.7389	0.1308	0.3734	0.4078	0.1281
U.S. Fall Run	0.1708	0.1946	0.1244	0.1239	0.1932	0.1249
Canadian Fall Run	0.0000	0.0665	0.0858	0.5027	0.3990	0.1296
U.S.	1.0000	0.9334	0.0858	0.4973	0.6010	0.1296
Canada	0.0000	0.0665	0.0858	0.5027	0.3990	0.1296
Summer Run	0.8292	0.7389	0.1308	0.3734	0.4078	0.1281
Fall Run	0.1708	0.2611	0.1308	0.6266	0.5922	0.1281

STOCK GROUPING	PERIOD # 7 AUG 6 TO AUG 10 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 12 TO AUG 17 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0222	0.0507	0.0568	0.0000	0.0192	0.0419
Mid-river Summer Run	0.0002	0.0324	0.0519	0.2051	0.1740	0.1046
Tanana River Fall Run	0.3692	0.3313	0.1317	0.4157	0.4078	0.1400
Chandalar/Sheenjek	0.3148	0.1846	0.1514	0.0000	0.0069	0.0280
Fishing Br./Canadian Mainstem	0.2937	0.3631	0.1767	0.3497	0.3214	0.1407
Upper Canadian Yukon	0.0000	0.0378	0.0592	0.0296	0.0707	0.0803
U.S. Summer Run	0.0224	0.0831	0.0680	0.2051	0.1932	0.1028
U.S. Fall Run	0.6840	0.5160	0.1739	0.4157	0.4147	0.1410
Canadian Fall Run	0.2937	0.4009	0.1724	0.3792	0.3921	0.1433
U.S.	0.7063	0.5991	0.1724	0.6208	0.6079	0.1433
Canada	0.2937	0.4009	0.1724	0.3792	0.3921	0.1433
Summer Run	0.0224	0.0831	0.0680	0.2051	0.1932	0.1028
Fall Run	0.9776	0.9169	0.0680	0.7949	0.8068	0.1028

Appendix IX. (continued)

STOCK GROUPING	PERIOD # 9 AUG 20 TO AUG 26		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0000	0.0093	0.0202
Mid-river Summer Run	0.0483	0.0556	0.0618
Tanana River Fall Run	0.5462	0.4984	0.1601
Chandalar/Sheenjek	0.0000	0.0178	0.0466
Fishing Br./Canadian Mainstem	0.2864	0.3027	0.1735
Upper Canadian Yukon	0.1191	0.1161	0.0901
U.S. Summer Run	0.0483	0.0649	0.0632
U.S. Fall Run	0.5462	0.5162	0.1564
Canadian Fall Run	0.4055	0.4188	0.1659
U.S.	0.5945	0.5812	0.1659
Canada	0.4055	0.4188	0.1659
Summer Run	0.0483	0.0649	0.0632
Fall Run	0.9517	0.9350	0.0632

Appendix X. Yukon River District 1 chum salmon harvest numbers by stock-grouping of origin in 1987. Estimates for 1987 were based on analysis of 12 loci.

STOCK GROUPING	PERIOD # 1 JUNE 16 TO JUNE 19			PERIOD # 2 JUNE 23 TO JUNE 26		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	27113	24223	3517	28164	26798	4508
Mid-river Summer Run	0	1303	1946	6826	6377	4887
Tanana River Fall Run	0	257	761	0	642	1333
Chandalar/Sheenjek	0	119	538	2056	956	1806
Fishing Br./Canadian Mainstem	3655	4601	2814	27	2061	3067
Upper Canadian Yukon	0	264	628	0	237	702
U.S. Summer Run	27113	25526	2779	34990	33176	3297
U.S. Fall Run	0	376	901	2056	1598	2144
Canadian Fall Run	3655	4865	2725	27	2298	3102
U.S.	27113	25902	2725	37047	34774	3101
Canada	3655	4865	2725	27	2298	3101
Summer Run	27113	25526	2779	34990	33176	3297
Fall Run	3655	5240	2779	2084	3896	3297
Total	30768	30766		37074	37072	

STOCK GROUPING	PERIOD # 3 JUNE 30 TO JULY 3			PERIOD # 4 JULY 6 TO JULY 11		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	78322	65060	16532	28678	26878	5034
Mid-river Summer Run	10931	24483	17054	8301	7847	4722
Tanana River Fall Run	908	1251	2939	0	96	413
Chandalar/Sheenjek	20725	15131	12197	0	505	1240
Fishing Br./Canadian Mainstem	377	6507	9608	49	1645	2183
Upper Canadian Yukon	6766	5589	6585	0	57	317
U.S. Summer Run	89252	89544	13924	36979	34724	2382
U.S. Fall Run	21633	16382	12349	0	601	1276
Canadian Fall Run	7143	12096	11938	49	1702	2221
U.S.	110885	105925	11972	36979	35325	2220
Canada	7143	12096	11972	49	1702	2220
Summer Run	89252	89544	13924	36979	34724	2382
Fall Run	28776	28477	13924	49	2302	2382
Total	118028	118021		37028	37027	

Appendix X. (continued)

STOCK GROUPING	PERIOD # 5 JULY 13 TO JULY 19 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 21 TO JULY 27 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0	0	0	0
Mid-river Summer Run	0	0	0	0	0	0
Tanana River Fall Run	0	0	0	0	0	0
Chandalar/Sheenjek	0	0	0	0	0	0
Fishing Br./Canadian Mainstem	0	0	0	0	0	0
Upper Canadian Yukon	0	0	0	0	0	0
U.S. Summer Run	0	0	0	0	0	0
U.S. Fall Run	0	0	0	0	0	0
Canadian Fall Run	0	0	0	0	0	0
U.S.	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Summer Run	0	0	0	0	0	0
Fall Run	0	0	0	0	0	0
Total	0	0		0	0	

STOCK GROUPING	PERIOD # 7 AUG 6 TO AUG 10 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 12 TO AUG 17 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0	0	0	0
Mid-river Summer Run	0	0	0	0	0	0
Tanana River Fall Run	0	0	0	0	0	0
Chandalar/Sheenjek	0	0	0	0	0	0
Fishing Br./Canadian Mainstem	0	0	0	0	0	0
Upper Canadian Yukon	0	0	0	0	0	0
U.S. Summer Run	0	0	0	0	0	0
U.S. Fall Run	0	0	0	0	0	0
Canadian Fall Run	0	0	0	0	0	0
U.S.	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Summer Run	0	0	0	0	0	0
Fall Run	0	0	0	0	0	0
Total	0	0		0	0	

Appendix X. (continued)

STOCK GROUPING	PERIOD # 9 AUG 20 TO AUG 26 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0
Mid-river Summer Run	0	0	0
Tanana River Fall Run	0	0	0
Chandalar/Sheenjek	0	0	0
Fishing Br./Canadian Mainstem	0	0	0
Upper Canadian Yukon	0	0	0
U.S. Summer Run	0	0	0
U.S. Fall Run	0	0	0
Canadian Fall Run	0	0	0
U.S.	0	0	0
Canada	0	0	0
Summer Run	0	0	0
Fall Run	0	0	0
Total	0	0	

Appendix XI. Yukon River District 1 chum salmon harvest proportions by stock-grouping of origin in 1988.

	PERIOD # 1 JUNE 5 TO JUNE 10			PERIOD # 2 JUNE 14 TO JUNE 17		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.8064	0.7753	0.0876	0.9575	0.8819	0.0705
Mid-river Summer Run	0.0267	0.0862	0.0808	0.0236	0.0794	0.0601
Tanana River Fall Run	0.0731	0.0281	0.0338	0.0000	0.0025	0.0086
Chandalar/Sheenjek	0.0426	0.0406	0.0540	0.0030	0.0218	0.0328
Fishing Br./Canadian Mainstem	0.0143	0.0358	0.0479	0.0000	0.0051	0.0140
Upper Canadian Yukon	0.0369	0.0340	0.0289	0.0158	0.0094	0.0185
U.S. Summer Run	0.8331	0.8615	0.0646	0.9812	0.9612	0.0364
U.S. Fall Run	0.1157	0.0687	0.0633	0.0030	0.0243	0.0333
Canadian Fall Run	0.0512	0.0697	0.0550	0.0158	0.0145	0.0224
U.S.	0.9488	0.9302	0.0551	0.9842	0.9855	0.0224
Canada	0.0512	0.0697	0.0551	0.0158	0.0145	0.0224
Summer Run	0.8331	0.8615	0.0646	0.9812	0.9612	0.0364
Fall Run	0.1669	0.1384	0.0646	0.0188	0.0387	0.0364

	PERIOD # 3 JUNE 21 TO JUNE 28			PERIOD # 4 JULY 1 TO JULY 8		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.8966	0.8235	0.0921	0.7829	0.7170	0.1122
Mid-river Summer Run	0.0922	0.1390	0.0945	0.2171	0.2403	0.1175
Tanana River Fall Run	0.0112	0.0257	0.0333	0.0000	0.0078	0.0221
Chandalar/Sheenjek	0.0000	0.0008	0.0044	0.0000	0.0106	0.0276
Fishing Br./Canadian Mainstem	0.0000	0.0105	0.0184	0.0000	0.0235	0.0336
Upper Canadian Yukon	0.0000	0.0004	0.0023	0.0000	0.0008	0.0034
U.S. Summer Run	0.9888	0.9625	0.0381	1.0000	0.9572	0.0483
U.S. Fall Run	0.0112	0.0265	0.0333	0.0000	0.0184	0.0367
Canadian Fall Run	0.0000	0.0109	0.0184	0.0000	0.0243	0.0337
U.S.	1.0000	0.9890	0.0184	1.0000	0.9756	0.0337
Canada	0.0000	0.0109	0.0184	0.0000	0.0243	0.0337
Summer Run	0.9888	0.9625	0.0381	1.0000	0.9572	0.0483
Fall Run	0.0112	0.0375	0.0381	0.0000	0.0427	0.0483

Appendix XI. (continued)

STOCK GROUPING	PERIOD # 5 JULY 10 TO JULY 15 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 17 TO JULY 26 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.5701	0.5122	0.1068	0.1325	0.1249	0.0842
Mid-river Summer Run	0.2271	0.2779	0.1215	0.1415	0.1479	0.1009
Tanana River Fall Run	0.0000	0.0147	0.0287	0.1344	0.1119	0.0955
Chandalar/Sheenjek	0.1849	0.1561	0.0948	0.2489	0.2717	0.1374
Fishing Br./Canadian Mainstem	0.0000	0.0205	0.0427	0.2508	0.2460	0.1334
Upper Canadian Yukon	0.0178	0.0184	0.0217	0.0984	0.0976	0.0626
U.S. Summer Run	0.7972	0.7901	0.0845	0.2740	0.2727	0.0949
U.S. Fall Run	0.1849	0.1708	0.0926	0.3833	0.3836	0.1559
Canadian Fall Run	0.0178	0.0390	0.0470	0.3493	0.3436	0.1407
U.S.	0.9822	0.9610	0.0470	0.6573	0.6564	0.1407
Canada	0.0178	0.0390	0.0470	0.3493	0.3436	0.1407
Summer Run	0.7972	0.7901	0.0845	0.2740	0.2727	0.0949
Fall Run	0.2028	0.2098	0.0845	0.7326	0.7272	0.0949

STOCK GROUPING	PERIOD # 7 JULY 27 TO AUG 6 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 8 TO AUG 16 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0938	0.0951	0.0861	0.0225	0.0281	0.0321
Mid-river Summer Run	0.0830	0.1532	0.1165	0.0352	0.1067	0.0833
Tanana River Fall Run	0.0505	0.1119	0.0846	0.4045	0.4074	0.0907
Chandalar/Sheenjek	0.4258	0.3386	0.1780	0.0530	0.1334	0.1099
Fishing Br./Canadian Mainstem	0.2710	0.2402	0.1707	0.4001	0.2371	0.1251
Upper Canadian Yukon	0.0759	0.0610	0.0617	0.0847	0.0873	0.0670
U.S. Summer Run	0.1767	0.2483	0.1249	0.0577	0.1348	0.0805
U.S. Fall Run	0.4763	0.4506	0.1801	0.4575	0.5408	0.1252
Canadian Fall Run	0.3470	0.3012	0.1674	0.4848	0.3244	0.1308
U.S.	0.6530	0.6988	0.1674	0.5152	0.6756	0.1308
Canada	0.3470	0.3012	0.1674	0.4848	0.3244	0.1308
Summer Run	0.1767	0.2483	0.1249	0.0577	0.1348	0.0804
Fall Run	0.8233	0.7517	0.1249	0.9423	0.8652	0.0804

Appendix XI. (continued)

STOCK GROUPING	PERIOD # 9 AUG 23 TO AUG 30 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0432	0.0752	0.0455
Mid-river Summer Run	0.0553	0.0648	0.0601
Tanana River Fall Run	0.7009	0.6281	0.0807
Chandalar/Sheenjek	0.1045	0.1061	0.0752
Fishing Br./Canadian Mainstem	0.0347	0.0639	0.0693
Upper Canadian Yukon	0.0613	0.0620	0.0345
U.S. Summer Run	0.0985	0.1399	0.0598
U.S. Fall Run	0.8055	0.7342	0.0850
Canadian Fall Run	0.0960	0.1259	0.0734
U.S.	0.9040	0.8741	0.0734
Canada	0.0960	0.1259	0.0734
Summer Run	0.0985	0.1399	0.0598
Fall Run	0.9015	0.8601	0.0598

Appendix XII. Yukon River District 1 chum salmon harvest numbers by stock-grouping of origin in 1988.

STOCK GROUPING	PERIOD # 1 JUNE 5 TO JUNE 10 GIRLSEM ESTIMATE	PERIOD # 1 BOOTSTRAP ESTIMATE	PERIOD # 1 BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 14 TO JUNE 17 GIRLSEM ESTIMATE	PERIOD # 2 BOOTSTRAP ESTIMATE	PERIOD # 2 BOOTSTRAP STAND DEV
Lower River Summer Run	51618	49628	5606	173175	159486	12755
Mid-river Summer Run	1710	5519	5172	4274	14357	10878
Tanana River Fall Run	4677	1800	2166	0	453	1560
Chandalar/Sheenjek	2729	2596	3457	547	3937	5940
Fishing Br./Canadian Mainstem	917	2290	3064	0	923	2535
Upper Canadian Yukon	2359	2175	1853	2858	1692	3346
U.S. Summer Run	53328	55147	4132	177450	173843	6578
U.S. Fall Run	7406	4396	4050	547	4390	6019
Canadian Fall Run	3276	4465	3523	2858	2615	4055
U.S.	60734	59543	3524	177996	178233	4053
Canada	3276	4465	3524	2858	2615	4053
Summer Run	53328	55147	4132	177450	173843	6578
Fall Run	10682	8861	4132	3404	7005	6578
Total	64010	64008		180854	180847	

STOCK GROUPING	PERIOD # 3 JUNE 21 TO JUNE 28 GIRLSEM ESTIMATE	PERIOD # 3 BOOTSTRAP ESTIMATE	PERIOD # 3 BOOTSTRAP STAND DEV	PERIOD # 4 JULY 1 TO JULY 8 GIRLSEM ESTIMATE	PERIOD # 4 BOOTSTRAP ESTIMATE	PERIOD # 4 BOOTSTRAP STAND DEV
Lower River Summer Run	186648	171425	19170	136122	124655	19513
Mid-river Summer Run	19201	28930	19666	37739	41777	20427
Tanana River Fall Run	2323	5360	6927	0	1355	3842
Chandalar/Sheenjek	0	166	916	1	1838	4804
Fishing Br./Canadian Mainstem	1	2185	3824	5	4083	5849
Upper Canadian Yukon	0	93	479	0	147	598
U.S. Summer Run	205848	200355	7935	173861	166433	8401
U.S. Fall Run	2323	5526	6940	1	3192	6385
Canadian Fall Run	1	2279	3832	5	4230	5861
U.S.	208171	205881	3833	173861	169625	5861
Canada	1	2279	3833	5	4230	5861
Summer Run	205848	200355	7935	173861	166433	8401
Fall Run	2324	7804	7935	5	7422	8401
Total	208172	208160		173866	173855	

Appendix XII. (continued)

STOCK GROUPING	PERIOD # 5 JULY 10 TO JULY 15 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 17 TO JULY 26 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	12142	10908	2275	0	0	0
Mid-river Summer Run	4837	5919	2587	0	0	0
Tanana River Fall Run	0	313	612	0	0	0
Chandalar/Sheenjek	3939	3325	2019	0	0	0
Fishing Br./Canadian Mainstem	0	437	910	0	0	0
Upper Canadian Yukon	379	392	462	0	0	0
U.S. Summer Run	16978	16827	1799	0	0	0
U.S. Fall Run	3939	3638	1972	0	0	0
Canadian Fall Run	379	830	1001	0	0	0
U.S.	20917	20465	1001	0	0	0
Canada	379	830	1001	0	0	0
Summer Run	16978	16827	1799	0	0	0
Fall Run	4318	4468	1799	0	0	0
Total	21296	21295		0	0	

STOCK GROUPING	PERIOD # 7 JULY 27 TO AUG 6 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 8 TO AUG 16 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0	731	911	1041
Mid-river Summer Run	0	0	0	1144	3466	2704
Tanana River Fall Run	0	0	0	13137	13233	2945
Chandalar/Sheenjek	0	0	0	1722	4332	3569
Fishing Br./Canadian Mainstem	0	0	0	12995	7701	4063
Upper Canadian Yukon	0	0	0	2751	2835	2175
U.S. Summer Run	0	0	0	1875	4377	2613
U.S. Fall Run	0	0	0	14859	17565	4067
Canadian Fall Run	0	0	0	15746	10536	4248
U.S.	0	0	0	16734	21942	4248
Canada	0	0	0	15746	10536	4248
Summer Run	0	0	0	1875	4377	2613
Fall Run	0	0	0	30605	28101	2613
Total	0	0		32480	32478	

Appendix XII. (continued)

STOCK GROUPING	PERIOD # 9 AUG 23 TO AUG 30 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	541	941	570
Mid-river Summer Run	693	811	752
Tanana River Fall Run	8773	7861	1010
Chandalar/Sheenjek	1308	1328	942
Fishing Br./Canadian Mainstem	434	800	868
Upper Canadian Yukon	767	775	432
U.S. Summer Run	1233	1751	748
U.S. Fall Run	10081	9189	1063
Canadian Fall Run	1202	1576	919
U.S.	11314	10940	919
Canada	1202	1576	919
Summer Run	1233	1751	748
Fall Run	11283	10764	748
Total	12516	12516	

Appendix XIII. Yukon River District 1 chum salmon harvest proportions by stock-grouping of origin in 1989.

STOCK GROUPING	PERIOD # 1 JUNE 13 TO JUNE 16			PERIOD # 2 JUNE 20 TO JUNE 25		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.9148	0.8342	0.0818	0.7869	0.7019	0.0947
Mid-river Summer Run	0.0818	0.1357	0.0762	0.1958	0.2208	0.0933
Tanana River Fall Run	0.0034	0.0234	0.0340	0.0078	0.0391	0.0420
Chandalar/Sheenjek	0.0000	0.0006	0.0028	0.0000	0.0059	0.0225
Fishing Br./Canadian Mainstem	0.0000	0.0060	0.0200	0.0001	0.0170	0.0290
Upper Canadian Yukon	0.0000	0.0000	0.0001	0.0093	0.0153	0.0203
U.S. Summer Run	0.9966	0.9699	0.0385	0.9827	0.9227	0.0497
U.S. Fall Run	0.0034	0.0240	0.0344	0.0078	0.0450	0.0437
Canadian Fall Run	0.0000	0.0060	0.0200	0.0094	0.0323	0.0339
U.S.	1.0000	0.9939	0.0200	0.9906	0.9676	0.0339
Canada	0.0000	0.0060	0.0200	0.0094	0.0323	0.0339
Summer Run	0.9966	0.9699	0.0385	0.9827	0.9227	0.0497
Fall Run	0.0034	0.0301	0.0385	0.0173	0.0773	0.0497

STOCK GROUPING	PERIOD # 3 JUNE 27 TO JUNE 30			PERIOD # 4 JULY 4 TO JULY 7		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.6641	0.6562	0.1262	0.7121	0.6719	0.1229
Mid-river Summer Run	0.3271	0.3101	0.1270	0.2373	0.2411	0.1205
Tanana River Fall Run	0.0087	0.0244	0.0393	0.0505	0.0573	0.0594
Chandalar/Sheenjek	0.0000	0.0001	0.0003	0.0001	0.0107	0.0222
Fishing Br./Canadian Mainstem	0.0000	0.0063	0.0140	0.0000	0.0143	0.0265
Upper Canadian Yukon	0.0000	0.0029	0.0130	0.0000	0.0047	0.0115
U.S. Summer Run	0.9913	0.9663	0.0459	0.9494	0.9130	0.0631
U.S. Fall Run	0.0087	0.0245	0.0395	0.0506	0.0680	0.0616
Canadian Fall Run	0.0000	0.0092	0.0214	0.0000	0.0189	0.0278
U.S.	1.0000	0.9908	0.0214	1.0000	0.9810	0.0278
Canada	0.0000	0.0092	0.0214	0.0000	0.0189	0.0278
Summer Run	0.9913	0.9663	0.0459	0.9494	0.9130	0.0631
Fall Run	0.0087	0.0336	0.0459	0.0506	0.0869	0.0631

Appendix XIII. (continued)

STOCK GROUPING	PERIOD # 5 JULY 11 TO JULY 16 GIRLSEM ESTIMATE	PERIOD # 5 BOOTSTRAP ESTIMATE	PERIOD # 5 BOOTSTRAP STAND DEV	PERIOD # 6 JULY 19 TO JULY 28 GIRLSEM ESTIMATE	PERIOD # 6 BOOTSTRAP ESTIMATE	PERIOD # 6 BOOTSTRAP STAND DEV
Lower River Summer Run	0.3770	0.3227	0.0808	0.1800	0.1524	0.0717
Mid-river Summer Run	0.0010	0.0722	0.0738	0.0692	0.1053	0.0716
Tanana River Fall Run	0.0154	0.0551	0.0539	0.1666	0.1561	0.0941
Chandalar/Sheenjek	0.2560	0.2145	0.1399	0.4104	0.3468	0.1452
Fishing Br./Canadian Mainstem	0.3134	0.2850	0.1320	0.0809	0.1533	0.1262
Upper Canadian Yukon	0.0372	0.0503	0.0453	0.0929	0.0860	0.0580
U.S. Summer Run	0.3780	0.3949	0.0965	0.2492	0.2577	0.0904
U.S. Fall Run	0.2713	0.2697	0.1475	0.5770	0.5030	0.1605
Canadian Fall Run	0.3506	0.3354	0.1275	0.1738	0.2393	0.1347
U.S.	0.6494	0.6646	0.1275	0.8262	0.7607	0.1347
Canada	0.3506	0.3354	0.1275	0.1738	0.2393	0.1347
Summer Run	0.3780	0.3949	0.0965	0.2492	0.2577	0.0904
Fall Run	0.6220	0.6050	0.0965	0.7508	0.7422	0.0904

STOCK GROUPING	PERIOD # 7 AUG 1 TO AUG 4 GIRLSEM ESTIMATE	PERIOD # 7 BOOTSTRAP ESTIMATE	PERIOD # 7 BOOTSTRAP STAND DEV	PERIOD # 8 AUG 8 TO AUG 11 GIRLSEM ESTIMATE	PERIOD # 8 BOOTSTRAP ESTIMATE	PERIOD # 8 BOOTSTRAP STAND DEV
Lower River Summer Run	0.0011	0.0478	0.0509	0.1221	0.1474	0.0784
Mid-river Summer Run	0.2358	0.1973	0.1138	0.1452	0.1634	0.1072
Tanana River Fall Run	0.1416	0.1683	0.1059	0.1842	0.1416	0.0894
Chandalar/Sheenjek	0.3129	0.2790	0.1504	0.4174	0.3294	0.1421
Fishing Br./Canadian Mainstem	0.1872	0.2087	0.1316	0.1249	0.1652	0.1163
Upper Canadian Yukon	0.1214	0.0988	0.0725	0.0062	0.0530	0.0633
U.S. Summer Run	0.2369	0.2451	0.1067	0.2673	0.3108	0.0873
U.S. Fall Run	0.4545	0.4473	0.1855	0.6016	0.4710	0.1560
Canadian Fall Run	0.3086	0.3075	0.1533	0.1311	0.2182	0.1193
U.S.	0.6914	0.6925	0.1533	0.8689	0.7818	0.1193
Canada	0.3086	0.3075	0.1533	0.1311	0.2182	0.1193
Summer Run	0.2369	0.2451	0.1067	0.2673	0.3108	0.0873
Fall Run	0.7631	0.7549	0.1067	0.7327	0.6892	0.0873

Appendix XIII. (continued)

STOCK GROUPING	PERIOD # 9 AUG 15 TO AUG 22 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0063	0.0334	0.0334
Mid-river Summer Run	0.1071	0.1322	0.0859
Tanana River Fall Run	0.4197	0.4534	0.0997
Chandalar/Sheenjek	0.0036	0.0531	0.0625
Fishing Br./Canadian Mainstem	0.4296	0.2955	0.1215
Upper Canadian Yukon	0.0337	0.0324	0.0349
U.S. Summer Run	0.1134	0.1656	0.0861
U.S. Fall Run	0.4233	0.5065	0.1187
Canadian Fall Run	0.4633	0.3279	0.1152
U.S.	0.5367	0.6721	0.1152
Canada	0.4633	0.3279	0.1152
Summer Run	0.1134	0.1656	0.0861
Fall Run	0.8866	0.8344	0.0861

Appendix XIV. Yukon River District 1 chum salmon harvest numbers by stock-grouping of origin in 1989.

STOCK GROUPING	PERIOD # 1 JUNE 13 TO JUNE 16 GIRLSEM ESTIMATE	PERIOD # 1 BOOTSTRAP ESTIMATE	PERIOD # 1 BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 20 TO JUNE 25 GIRLSEM ESTIMATE	PERIOD # 2 BOOTSTRAP ESTIMATE	PERIOD # 2 BOOTSTRAP STAND DEV
Lower River Summer Run	131805	120197	11785	113143	100912	13620
Mid-river Summer Run	11788	19554	10981	28156	31747	13413
Tanana River Fall Run	495	3378	4902	1127	5621	6037
Chandalar/Sheenjek	0	83	402	1	845	3232
Fishing Br./Canadian Mainstem	0	867	2886	12	2446	4162
Upper Canadian Yukon	0	3	17	1342	2199	2921
U.S. Summer Run	143592	139751	5548	141299	132659	7144
U.S. Fall Run	495	3461	4950	1127	6466	6278
Canadian Fall Run	0	870	2886	1354	4645	4870
U.S.	144087	143211	2886	142426	139125	4868
Canada	0	870	2886	1354	4645	4868
Summer Run	143592	139751	5546	141299	132659	7144
Fall Run	495	4330	5546	2481	11111	7144
Total	144087	144081		143780	143770	

STOCK GROUPING	PERIOD # 3 JUNE 27 TO JUNE 30 GIRLSEM ESTIMATE	PERIOD # 3 BOOTSTRAP ESTIMATE	PERIOD # 3 BOOTSTRAP STAND DEV	PERIOD # 4 JULY 4 TO JULY 7 GIRLSEM ESTIMATE	PERIOD # 4 BOOTSTRAP ESTIMATE	PERIOD # 4 BOOTSTRAP STAND DEV
Lower River Summer Run	108615	107314	20642	40964	38653	7069
Mid-river Summer Run	53501	50719	20769	13649	13867	6934
Tanana River Fall Run	1427	3987	6433	2908	3299	3416
Chandalar/Sheenjek	0	12	47	4	613	1278
Fishing Br./Canadian Mainstem	0	1032	2294	0	821	1524
Upper Canadian Yukon	0	470	2132	0	268	659
U.S. Summer Run	162116	158032	7503	54612	52520	3627
U.S. Fall Run	1427	3999	6453	2911	3912	3543
Canadian Fall Run	0	1501	3499	0	1089	1599
U.S.	163543	162031	3499	57524	56432	1598
Canada	0	1501	3499	0	1089	1598
Summer Run	162116	158032	7499	54612	52520	3627
Fall Run	1427	5500	7499	2911	5000	3627
Total	163543	163532		57524	57521	

Appendix XIV. (contiued)

STOCK GROUPING	PERIOD # 5 JULY 11 TO JULY 16 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 19 TO JULY 28 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	14589	12487	3128	788	668	314
Mid-river Summer Run	40	2796	2857	303	461	313
Tanana River Fall Run	595	2134	2087	730	684	412
Chandalar/Sheenjek	9906	8302	5413	1798	1520	636
Fishing Br./Canadian Mainstem	12128	11029	5108	354	671	553
Upper Canadian Yukon	1440	1948	1754	407	377	254
U.S. Summer Run	14629	15283	3734	1092	1129	396
U.S. Fall Run	10500	10436	5707	2528	2204	703
Canadian Fall Run	13568	12977	4934	762	1048	590
U.S.	25129	25719	4934	3619	3333	590
Canada	13568	12977	4934	762	1048	590
Summer Run	14629	15283	3734	1092	1129	396
Fall Run	24068	23413	3734	3289	3252	396
Total	38697	38696		4381	4381	

STOCK GROUPING	PERIOD # 7 AUG 1 TO AUG 4 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 8 TO AUG 11 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	55	2344	2493	776	936	498
Mid-river Summer Run	11555	9668	5578	922	1038	681
Tanana River Fall Run	6938	8248	5189	1171	900	568
Chandalar/Sheenjek	15333	13672	7371	2652	2093	903
Fishing Br./Canadian Mainstem	9172	10228	6447	794	1050	739
Upper Canadian Yukon	5950	4841	3552	39	337	402
U.S. Summer Run	11610	12012	5231	1698	1975	555
U.S. Fall Run	22271	21920	9088	3823	2993	991
Canadian Fall Run	15122	15070	7514	833	1386	758
U.S.	33881	33932	7513	5521	4967	758
Canada	15122	15070	7513	833	1386	758
Summer Run	11610	12012	5231	1698	1975	555
Fall Run	37393	36990	5231	4656	4379	555
Total	49003	49002		6354	6354	

Appendix XIV. (continued)

	PERIOD # 9 AUG 15 TO AUG 22		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	114	605	606
Mid-river Summer Run	1942	2398	1558
Tanana River Fall Run	7613	8223	1808
Chandalar/Sheenjek	65	963	1133
Fishing Br./Canadian Mainstem	7792	5360	2204
Upper Canadian Yukon	612	588	633
U.S. Summer Run	2056	3004	1561
U.S. Fall Run	7678	9186	2154
Canadian Fall Run	8404	5947	2089
U.S.	9734	12190	2089
Canada	8404	5947	2089
Summer Run	2056	3004	1561
Fall Run	16082	15134	1561
Total	18138	18137	

Appendix XV. Yukon River District 1 chum salmon harvest proportions by stock-grouping of origin in 1990.

STOCK GROUPING	PERIOD # 1 JUNE 6 TO JUNE 13 GIRLSEM ESTIMATE	PERIOD # 1 BOOTSTRAP ESTIMATE	PERIOD # 1 BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 15 TO JUNE 19 GIRLSEM ESTIMATE	PERIOD # 2 BOOTSTRAP ESTIMATE	PERIOD # 2 BOOTSTRAP STAND DEV
Lower River Summer Run	0.8593	0.8015	0.0979	0.8147	0.7188	0.0961
Mid-river Summer Run	0.0044	0.0689	0.0832	0.1294	0.1864	0.0995
Tanana River Fall Run	0.0636	0.0646	0.0524	0.0388	0.0549	0.0539
Chandalar/Sheenjek	0.0000	0.0051	0.0159	0.0016	0.0165	0.0319
Fishing Br/Canadian Mainstem	0.0728	0.0504	0.0646	0.0000	0.0087	0.0209
Upper Canadian Yukon	0.0000	0.0095	0.0165	0.0154	0.0147	0.0225
U.S. Summer Run	0.8637	0.8704	0.0693	0.9441	0.9052	0.0628
U.S. Fall Run	0.0636	0.0697	0.0553	0.0405	0.0713	0.0608
Canadian Fall Run	0.0728	0.0598	0.0658	0.0154	0.0234	0.0287
U.S.	0.9272	0.9401	0.0658	0.9846	0.9765	0.0287
Canada	0.0728	0.0598	0.0658	0.0154	0.0234	0.0287
Summer Run	0.8637	0.8704	0.0693	0.9441	0.9052	0.0628
Fall Run	0.1363	0.1295	0.0693	0.0559	0.0948	0.0628

STOCK GROUPING	PERIOD # 3 JUNE 22 TO JUNE 29 GIRLSEM ESTIMATE	PERIOD # 3 BOOTSTRAP ESTIMATE	PERIOD # 3 BOOTSTRAP STAND DEV	PERIOD # 4 JULY 3 TO JULY 11 GIRLSEM ESTIMATE	PERIOD # 4 BOOTSTRAP ESTIMATE	PERIOD # 4 BOOTSTRAP STAND DEV
Lower River Summer Run	0.9133	0.8456	0.0757	0.7074	0.6893	0.1048
Mid-river Summer Run	0.0854	0.0996	0.0712	0.2722	0.2114	0.1113
Tanana River Fall Run	0.0001	0.0140	0.0258	0.0015	0.0309	0.0454
Chandalar/Sheenjek	0.0000	0.0046	0.0140	0.0000	0.0084	0.0244
Fishing Br/Canadian Mainstem	0.0011	0.0302	0.0326	0.0113	0.0407	0.0467
Upper Canadian Yukon	0.0000	0.0060	0.0109	0.0076	0.0192	0.0245
U.S. Summer Run	0.9987	0.9452	0.0449	0.9796	0.9008	0.0627
U.S. Fall Run	0.0001	0.0186	0.0292	0.0016	0.0393	0.0491
Canadian Fall Run	0.0011	0.0362	0.0349	0.0189	0.0599	0.0528
U.S.	0.9989	0.9637	0.0349	0.9811	0.9401	0.0528
Canada	0.0011	0.0362	0.0349	0.0189	0.0599	0.0528
Summer Run	0.9987	0.9452	0.0449	0.9796	0.9008	0.0627
Fall Run	0.0013	0.0548	0.0449	0.0204	0.0992	0.0627

Appendix XV. (continued)

STOCK GROUPING	PERIOD # 5 JULY 14 TO JULY 20			PERIOD # 6 JULY 24 TO JULY 31		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.2066	0.1919	0.0920	0.4143	0.3371	0.1121
Mid-river Summer Run	0.0172	0.1089	0.0996	0.0029	0.0747	0.0880
Tanana River Fall Run	0.0021	0.0541	0.0689	0.0441	0.0708	0.0787
Chandalar/Sheenjek	0.3827	0.3203	0.1520	0.1771	0.1704	0.1319
Fishing Br/Canadian Mainstem	0.1872	0.1404	0.1201	0.3164	0.2865	0.1463
Upper Canadian Yukon	0.2043	0.1844	0.0733	0.0452	0.0603	0.0541
U.S. Summer Run	0.2238	0.3008	0.1134	0.4173	0.4118	0.1100
U.S. Fall Run	0.3847	0.3743	0.1562	0.2212	0.2413	0.1431
Canadian Fall Run	0.3915	0.3248	0.1355	0.3616	0.3468	0.1452
U.S.	0.6085	0.6751	0.1355	0.6384	0.6531	0.1452
Canada	0.3915	0.3248	0.1355	0.3616	0.3468	0.1452
Summer Run	0.2238	0.3008	0.1134	0.4173	0.4118	0.1099
Fall Run	0.7762	0.6992	0.1134	0.5827	0.5881	0.1099

STOCK GROUPING	PERIOD # 7 AUG 3 TO AUG 8			PERIOD # 8 AUG 11 TO AUG 18		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0000	0.0118	0.0269	0.0000	0.0288	0.0320
Mid-river Summer Run	0.0000	0.0344	0.0492	0.0007	0.0513	0.0724
Tanana River Fall Run	0.2205	0.1986	0.0881	0.3006	0.2964	0.1302
Chandalar/Sheenjek	0.3130	0.3312	0.1449	0.0498	0.0830	0.0954
Fishing Br/Canadian Mainstem	0.3074	0.2782	0.1338	0.6119	0.4849	0.1684
Upper Canadian Yukon	0.1591	0.1458	0.0757	0.0369	0.0555	0.0618
U.S. Summer Run	0.0000	0.0462	0.0560	0.0007	0.0801	0.0785
U.S. Fall Run	0.5335	0.5298	0.1545	0.3505	0.3794	0.1554
Canadian Fall Run	0.4665	0.4240	0.1486	0.6488	0.5404	0.1637
U.S.	0.5335	0.5760	0.1486	0.3512	0.4595	0.1637
Canada	0.4665	0.4240	0.1486	0.6488	0.5404	0.1637
Summer Run	0.0000	0.0462	0.0560	0.0007	0.0801	0.0785
Fall Run	1.0000	0.9538	0.0560	0.9993	0.9199	0.0785

Appendix XV. (continued)

	PERIOD # 9 AUG 20 TO AUG 23		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0.0001	0.0230	0.0364
Mid-river Summer Run	0.0006	0.0399	0.0576
Tanana River Fall Run	0.4424	0.4246	0.1222
Chandalar/Sheenjek	0.0011	0.0526	0.0738
Fishing Br/Canadian Mainstem	0.4748	0.3915	0.1393
Upper Canadian Yukon	0.0811	0.0683	0.0489
U.S. Summer Run	0.0007	0.0629	0.0625
U.S. Fall Run	0.4435	0.4773	0.1335
Canadian Fall Run	0.5558	0.4597	0.1380
U.S.	0.4442	0.5402	0.1380
Canada	0.5558	0.4597	0.1380
Summer Run	0.0007	0.0629	0.0625
Fall Run	0.9993	0.9370	0.0625

Appendix XVI. Yukon River District 1 chum salmon harvest numbers by stock-grouping of origin in 1990.

STOCK GROUPING	PERIOD # 1 JUNE 6 TO JUNE 13 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 15 TO JUNE 19 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0	88005	77647	10382
Mid-river Summer Run	0	0	0	13981	20130	10752
Tanana River Fall Run	0	0	0	4194	5929	5825
Chandalar/Sheenjek	0	0	0	178	1777	3441
Fishing Br./Canadian Mainstem	0	0	0	3	942	2257
Upper Canadian Yukon	0	0	0	1659	1589	2428
U.S. Summer Run	0	0	0	101986	97777	6784
U.S. Fall Run	0	0	0	4372	7706	6567
Canadian Fall Run	0	0	0	1662	2531	3098
U.S.	0	0	0	106358	105483	3096
Canada	0	0	0	1662	2531	3096
Summer Run	0	0	0	101986	97777	6784
Fall Run	0	0	0	6034	10237	6784
Total	0	0		108020	108014	

STOCK GROUPING	PERIOD # 3 JUNE 22 TO JUNE 29 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 4 JULY 3 TO JULY 11 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	32558	30143	2697	3709	3614	549
Mid-river Summer Run	3045	3551	2538	1427	1109	583
Tanana River Fall Run	4	500	920	8	162	238
Chandalar/Sheenjek	1	163	498	0	44	128
Fishing Br./Canadian Mainstem	40	1077	1162	59	213	245
Upper Canadian Yukon	0	214	388	40	101	129
U.S. Summer Run	35603	33693	1602	5136	4723	329
U.S. Fall Run	5	662	1042	8	206	257
Canadian Fall Run	40	1291	1243	99	314	277
U.S.	35608	34356	1243	5144	4929	277
Canada	40	1291	1243	99	314	277
Summer Run	35603	33693	1601	5136	4723	329
Fall Run	45	1953	1601	107	520	329
Total	35648	35646		5243	5243	

Appendix XVI. (continued)

STOCK GROUPING	PERIOD # 5 JULY 14 TO JULY 20 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 6 JULY 24 TO JULY 31 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	0	0	1865	1517	505
Mid-river Summer Run	0	0	0	13	336	396
Tanana River Fall Run	0	0	0	198	319	354
Chandalar/Sheenjek	0	0	0	797	767	594
Fishing Br./Canadian Mainstem	0	0	0	1424	1290	658
Upper Canadian Yukon	0	0	0	203	271	244
U.S. Summer Run	0	0	0	1878	1854	495
U.S. Fall Run	0	0	0	995	1086	644
Canadian Fall Run	0	0	0	1627	1561	653
U.S.	0	0	0	2874	2940	653
Canada	0	0	0	1627	1561	653
Summer Run	0	0	0	1878	1854	495
Fall Run	0	0	0	2623	2647	495
Total	0	0		4501	4501	

STOCK GROUPING	PERIOD # 7 AUG 3 TO AUG 8 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	PERIOD # 8 AUG 11 TO AUG 18 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	221	503	0	0	0
Mid-river Summer Run	0	643	921	0	0	0
Tanana River Fall Run	4129	3720	1651	0	0	0
Chandalar/Sheenjek	5863	6202	2714	0	0	0
Fishing Br./Canadian Mainstem	5756	5211	2505	0	0	0
Upper Canadian Yukon	2980	2730	1417	0	0	0
U.S. Summer Run	0	865	1049	0	0	0
U.S. Fall Run	9992	9922	2894	0	0	0
Canadian Fall Run	8736	7941	2783	0	0	0
U.S.	9992	10786	2782	0	0	0
Canada	8736	7941	2782	0	0	0
Summer Run	0	865	1049	0	0	0
Fall Run	18728	17863	1049	0	0	0
Total	18728	18727		0	0	

Appendix XVI. (continued)

	PERIOD # 9 AUG 20 TO AUG 23		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River Summer Run	0	95	149
Mid-river Summer Run	3	164	237
Tanana River Fall Run	1817	1744	502
Chandalar/Sheenjek	4	216	303
Fishing Br./Canadian Mainstem	1950	1608	572
Upper Canadian Yukon	333	280	201
U.S. Summer Run	3	259	257
U.S. Fall Run	1822	1961	549
Canadian Fall Run	2283	1889	567
U.S.	1825	2219	567
Canada	2283	1889	567
Summer Run	3	259	257
Fall Run	4105	3849	257
Total	4108	4108	

Appendix XVII. Yukon River District 1 chinook salmon harvest proportions by stock-grouping of origin in 1987.

STOCK GROUPING	PERIOD # 1 JUNE 5 TO JUNE 13			PERIOD # 2 JUNE 16 TO JUNE 23		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.0645	0.0837	0.0417	0.1943	0.1962	0.0475
Mid-river-USA	0.2259	0.2377	0.0538	0.1123	0.1194	0.0382
Lower Canadian Yukon	0.2148	0.1879	0.0555	0.0865	0.0927	0.0410
Pelly	0.3154	0.3075	0.0581	0.2667	0.2718	0.0499
Mid-river Canadian Yukon	0.1468	0.1604	0.0628	0.3393	0.3040	0.0647
Takhini	0.0327	0.0262	0.0231	0.0010	0.0159	0.0228
United States	0.2903	0.3180	0.0574	0.3066	0.3156	0.0493
Canada	0.7097	0.6820	0.0574	0.6934	0.6844	0.0493

STOCK GROUPING	PERIOD # 3 JUNE 26 TO JULY 3			PERIOD # 4 JULY 6 TO JULY 15		
	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.3855	0.3797	0.0583	0.7720	0.7862	0.0615
Mid-river-USA	0.1342	0.1361	0.0399	0.0510	0.0451	0.0346
Lower Canadian Yukon	0.0433	0.0465	0.0348	0.0000	0.0003	0.0017
Pelly	0.0812	0.0868	0.0436	0.0315	0.0353	0.0302
Mid-river Canadian Yukon	0.2895	0.2938	0.0638	0.0939	0.0741	0.0516
Takhini	0.0662	0.0572	0.0400	0.0517	0.0589	0.0424
United States	0.5197	0.5158	0.0501	0.8229	0.8313	0.0523
Canada	0.4803	0.4842	0.0501	0.1771	0.1687	0.0523

Appendix XVIII. Yukon River District 1 chinook salmon harvest numbers by stock-grouping of origin in 1987.

	PERIOD # 1 JUNE 5 TO JUNE 13			PERIOD # 2 JUNE 16 TO JUNE 23		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.0000	0.0000	0.0000	9816	9915	2400
Mid-river-USA	0.0000	0.0000	0.0000	5674	6030	1932
Lower Canadian Yukon	0.0000	0.0000	0.0000	4368	4682	2072
Pelly	0.0000	0.0000	0.0000	13474	13731	2521
Mid-river Canadian Yukon	0.0000	0.0000	0.0000	17142	15360	3268
Takhini	0.0000	0.0000	0.0000	49	805	1151
United States	0.0000	0.0000	0.0000	15490	15945	2493
Canada	0.0000	0.0000	0.0000	35034	34578	2493
Total	0.0000	0.0000		50524	50523	

	PERIOD # 3 JUNE 26 TO JULY 3			PERIOD # 4 JULY 6 TO JULY 15		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	9327	9187	1411	1486	1513	118
Mid-river-USA	3247	3292	964	98	87	67
Lower Canadian Yukon	1048	1125	842	0	1	3
Pelly	1965	2099	1055	61	68	58
Mid-river Canadian Yukon	7003	7106	1544	181	143	99
Takhini	1603	1383	967	100	113	82
United States	12574	12478	1211	1584	1600	101
Canada	11618	11713	1211	341	325	101
Total	24192	24192		1925	1925	

Appendix XIX. Yukon River District 1 chinook salmon harvest proportions by stock-grouping of origin in 1988.

	PERIOD # 1 JUNE 5 TO JUNE 10			PERIOD # 2 JUNE 14 TO JUNE 17		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.1591	0.1665	0.0589	0.1808	0.1751	0.0530
Mid-river-USA	0.2746	0.2677	0.0517	0.2240	0.2347	0.0585
Lower Canadian Yukon	0.0868	0.0919	0.0458	0.0509	0.0427	0.0313
Pelly	0.2837	0.2794	0.0571	0.2269	0.2075	0.0592
Mid-river Canadian Yukon	0.1958	0.1907	0.0581	0.3141	0.3324	0.0640
Takhini	0.0000	0.0038	0.0130	0.0032	0.0076	0.0131
United States	0.4337	0.4342	0.0570	0.4048	0.4098	0.0584
Canada	0.5663	0.5658	0.0570	0.5952	0.5902	0.0584

	PERIOD # 3 JUNE 21 TO JUNE 29			PERIOD # 4 JUNE 30 TO JULY 8		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.4356	0.4391	0.0543	0.4883	0.4944	0.0607
Mid-river-USA	0.0897	0.1018	0.0457	0.0670	0.0703	0.0307
Lower Canadian Yukon	0.0394	0.0256	0.0280	0.0847	0.0740	0.0435
Pelly	0.1322	0.1158	0.0336	0.0486	0.0527	0.0412
Mid-river Canadian Yukon	0.2964	0.3057	0.0588	0.1689	0.1741	0.0711
Takhini	0.0068	0.0122	0.0194	0.1424	0.1345	0.0609
United States	0.5253	0.5408	0.0490	0.5553	0.5647	0.0578
Canada	0.4747	0.4592	0.0490	0.4447	0.4353	0.0578

Appendix XIX. (continued)

	PERIOD # 5 JULY 11 TO JULY 15		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.5718	0.5490	0.0949
Mid-river-USA	0.1451	0.1523	0.0645
Lower Canadian Yukon	0.0851	0.0923	0.0610
Pelly	0.0001	0.0127	0.0293
Mid-river Canadian Yukon	0.1813	0.1596	0.0815
Takhini	0.0166	0.0340	0.0456
United States	0.7169	0.7013	0.0735
Canada	0.2831	0.2987	0.0735

Appendix XX. Yukon River District 1 chinook salmon harvest numbers by stock-grouping of origin in 1988.

STOCK GROUPING	PERIOD # 1 JUNE 5 TO JUNE 10 GIRLSEM ESTIMATE	PERIOD # 1 BOOTSTRAP ESTIMATE	PERIOD # 1 BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 14 TO JUNE 17 GIRLSEM ESTIMATE	PERIOD # 2 BOOTSTRAP ESTIMATE	PERIOD # 2 BOOTSTRAP STAND DEV
Lower River-USA	530	554	196	4245	4112	1245
Mid-river-USA	914	892	172	5261	5511	1374
Lower Canadian Yukon	289	306	153	1195	1004	734
Pelly	945	930	190	5329	4872	1391
Mid-river Canadian Yukon	652	635	194	7377	7805	1504
Takhini	0	13	43	75	179	308
United States	1444	1446	190	9507	9623	1370
Canada	1886	1884	190	13976	13860	1370
Total	3330	3330		23483	23483	

STOCK GROUPING	PERIOD # 3 JUNE 21 TO JUNE 29 GIRLSEM ESTIMATE	PERIOD # 3 BOOTSTRAP ESTIMATE	PERIOD # 3 BOOTSTRAP STAND DEV	PERIOD # 4 JUNE 30 TO JULY 8 GIRLSEM ESTIMATE	PERIOD # 4 BOOTSTRAP ESTIMATE	PERIOD # 4 BOOTSTRAP STAND DEV
Lower River-USA	10025	10103	1249	3320	3361	413
Mid-river-USA	2063	2342	1051	456	478	209
Lower Canadian Yukon	906	588	644	576	503	296
Pelly	3042	2665	772	331	359	280
Mid-river Canadian Yukon	6820	7034	1353	1149	1183	483
Takhini	156	280	445	968	914	414
United States	12088	12445	1128	3775	3840	393
Canada	10924	10567	1128	3024	2959	393
Total	23012	23012		6799	6799	

Appendix XX. (continued)

STOCK GROUPING	PERIOD # 5 JULY 11 TO JULY 15 GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	266	255	44
Mid-river-USA	67	71	30
Lower Canadian Yukon	40	43	28
Pelly	0	6	14
Mid-river Canadian Yukon	84	74	38
Takhini	8	16	21
United States	333	326	34
Canada	132	139	34
Total	465	465	

Appendix XXI. Yukon River District 1 chinook salmon harvest proportions by stock-grouping of origin in 1989.

	PERIOD # 1 JUNE 10 TO JUNE 16			PERIOD # 2 JUNE 20 TO JUNE 25		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.1328	0.1430	0.0540	0.2849	0.2752	0.0431
Mid-river-USA	0.2631	0.2597	0.0538	0.2108	0.2242	0.0392
Lower Canadian Yukon	0.0544	0.0704	0.0348	0.0121	0.0214	0.0183
Pelly	0.2012	0.2055	0.0514	0.1394	0.1405	0.0328
Mid-river Canadian Yukon	0.3228	0.2968	0.0581	0.2956	0.2817	0.0485
Takhini	0.0257	0.0247	0.0240	0.0572	0.0569	0.0329
United States	0.3959	0.4027	0.0465	0.4958	0.4995	0.0377
Canada	0.6041	0.5973	0.0465	0.5042	0.5005	0.0377

	PERIOD # 3 JUNE 27 TO JUNE 30			PERIOD # 4 JULY 4 TO JULY 14		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.6158	0.6098	0.0642	0.6268	0.6126	0.0559
Mid-river-USA	0.1815	0.1789	0.0681	0.0802	0.0936	0.0347
Lower Canadian Yukon	0.0007	0.0189	0.0340	0.0782	0.0737	0.0398
Pelly	0.0315	0.0324	0.0224	0.0000	0.0002	0.0010
Mid-river Canadian Yukon	0.1704	0.1532	0.0463	0.1532	0.1753	0.0547
Takhini	0.0000	0.0068	0.0135	0.0616	0.0447	0.0368
United States	0.7974	0.7887	0.0541	0.7070	0.7062	0.0512
Canada	0.2026	0.2113	0.0541	0.2930	0.2938	0.0512

Appendix XXII. Yukon River District 1 chinook salmon harvest numbers by stock-grouping of origin in 1989.

STOCK GROUPING	PERIOD # 1 JUNE 10 TO JUNE 16 GIRLSEM ESTIMATE	PERIOD # 1 BOOTSTRAP ESTIMATE	PERIOD # 1 BOOTSTRAP STAND DEV	PERIOD # 2 JUNE 20 TO JUNE 25 GIRLSEM ESTIMATE	PERIOD # 2 BOOTSTRAP ESTIMATE	PERIOD # 2 BOOTSTRAP STAND DEV
Lower River-USA	914	984	371	9170	8857	1388
Mid-river-USA	1811	1787	370	6784	7216	1260
Lower Canadian Yukon	375	484	240	388	689	589
Pelly	1384	1414	354	4485	4523	1057
Mid-river Canadian Yukon	2221	2043	400	9512	9064	1561
Takhini	177	170	165	1841	1831	1059
United States	2725	2771	320	15954	16073	1213
Canada	4157	4111	320	16226	16107	1213
Total	6882	6882		32180	32180	

STOCK GROUPING	PERIOD # 3 JUNE 27 TO JUNE 30 GIRLSEM ESTIMATE	PERIOD # 3 BOOTSTRAP ESTIMATE	PERIOD # 3 BOOTSTRAP STAND DEV	PERIOD # 4 JULY 4 TO JULY 14 GIRLSEM ESTIMATE	PERIOD # 4 BOOTSTRAP ESTIMATE	PERIOD # 4 BOOTSTRAP STAND DEV
Lower River-USA	6428	6365	670	1171	1144	104
Mid-river-USA	1895	1868	711	150	175	65
Lower Canadian Yukon	7	197	354	146	138	74
Pelly	329	338	233	0	0	2
Mid-river Canadian Yukon	1779	1599	484	286	328	102
Takhini	0	71	141	115	83	69
United States	8323	8232	565	1321	1319	96
Canada	2115	2206	565	547	549	96
Total	10438	10438		1868	1868	

Appendix XXIII. Yukon River District 1 chinook salmon harvest proportions by stock-grouping of origin in 1990.

	PERIOD # 1 JUNE 7 TO JUNE 15			PERIOD # 2 JUNE 19 TO JUNE 22		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.1004	0.1062	0.0400	0.3776	0.3717	0.0604
Mid-river-USA	0.2966	0.2871	0.0626	0.1479	0.1503	0.0543
Lower Canadian Yukon	0.1142	0.1209	0.0545	0.0186	0.0299	0.0269
Pelly	0.2069	0.2105	0.0508	0.1237	0.1264	0.0560
Mid-river Canadian Yukon	0.2810	0.2634	0.0616	0.2673	0.2592	0.0659
Takhini	0.0009	0.0119	0.0169	0.0649	0.0626	0.0417
United States	0.3970	0.3933	0.0605	0.5256	0.5220	0.0565
Canada	0.6030	0.6067	0.0605	0.4744	0.4780	0.0565

	PERIOD # 3 JUNE 25 TO JUNE 29			PERIOD # 4 JULY 2 TO JULY 15		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	0.5552	0.5443	0.0574	0.5762	0.5647	0.0645
Mid-river-USA	0.0806	0.1037	0.0381	0.1005	0.1070	0.0453
Lower Canadian Yukon	0.0309	0.0232	0.0252	0.0544	0.0454	0.0350
Pelly	0.0808	0.0729	0.0361	0.0631	0.0717	0.0349
Mid-river Canadian Yukon	0.1832	0.1940	0.0644	0.1314	0.1438	0.0575
Takhini	0.0694	0.0620	0.0364	0.0743	0.0674	0.0416
United States	0.6359	0.6480	0.0528	0.6768	0.6717	0.0538
Canada	0.3641	0.3520	0.0528	0.3232	0.3283	0.0538

Appendix XXIV. Yukon River District 1 chinook salmon harvest numbers by stock-grouping of origin in 1990.

	PERIOD # 1 JUNE 7 TO JUNE 15			PERIOD # 2 JUNE 19 TO JUNE 22		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	1900	2010	756	9062	8919	1449
Mid-river-USA	5611	5431	1184	3550	3607	1303
Lower Canadian Yukon	2161	2287	1031	446	718	646
Pelly	3914	3983	962	2968	3032	1343
Mid-river Canadian Yukon	5316	4983	1165	6414	6219	1581
Takhini	17	225	320	1557	1501	1002
United States	7511	7441	1145	12611	12526	1355
Canada	11409	11478	1145	11385	11470	1355
Total	18920	18920		23996	23996	

	PERIOD # 3 JUNE 25 TO JUNE 29			PERIOD # 4 JULY 2 TO JULY 15		
STOCK GROUPING	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV	GIRLSEM ESTIMATE	BOOTSTRAP ESTIMATE	BOOTSTRAP STAND DEV
Lower River-USA	3602	3531	372	959	940	107
Mid-river-USA	523	673	247	167	178	75
Lower Canadian Yukon	200	150	163	91	76	58
Pelly	524	473	234	105	119	58
Mid-river Canadian Yukon	1188	1258	418	219	239	96
Takhini	450	402	236	124	112	69
United States	4125	4204	342	1127	1118	90
Canada	2362	2283	342	538	547	90
Total	6487	6487		1665	1665	

Appendix XXV. Buffer protocol used in electrophoresis of Yukon River salmon samples.

Buffer Name	Chemical	Concentration (M)		pH	
		Gel	Electrode	Gel	Electrode
CAM 6.05 CAM 6.3 CAM 6.8	Citric acid (monohydrate)	0.002	0.040	pH with N-(3-aminopropyl) morpholine	
CAME 7.0	Citric acid (monohydrate)	0.002	0.040	pH with N-(3-aminopropyl) morpholine	
	EDTA (tetrasodium salt)	2.5×10^{-5}	0.0		
EBT	Tris	0.045	0.18	Do not adjust pH	
	EDTA	9.75×10^{-4}	3.9×10^{-3}		
	Boric Acid	0.025	0.10		
KG	Tris	0.0248	0.074	8.5	8.9
	Glycine	0.192	0.192		
TC-4	Tris	0.008	0.223	5.95	5.80
	Citric acid (monohydrate)	0.003	0.086		